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1983-84

DEPARTMENT OF OCEAN DEVELOPMENT
GOVERNMENT OF INDIA
NEW DELHI

Postal Address

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INTRODUC ION

The Indian Ocean surrounds the Indian subcontinent. It has its northern boundary closed by the land mass, but to the south it extends right upto the icy continent of Antarctica. For several centuries the people of India have been using the seas around India for transport and communication and for food. However, on 10 December 1982, a new regime of the oceans has come into existence when 120 countries signed the UN Convention on the Law of the Sea (UNCLOS) in Montego Bay, Jamaica. Thus it is now possible to use the vast resources of the sea, which was once known as the common heritage of mankind. The new laws hold an immense promise for the development of the oceans and particularly for the developing countries, in as much as their rights of sharing the wealth of the oceans are now protected.

Under the new regime, India has a very important role to play in the Indian Ocean region. It has a major responsibility because most of the nations bordering the Indian Ocean are developing countries with considerable population pressure and at a low level of economic development.

As a first step in this direction, a new Department of Ocean Development was created on 24 July 1981 directly under the Prime Minister. Since its inception, the Department has played a key role in effectively projecting India's image in the UNCLOS and in the meetings of the Preparatory Commission of the International Sea Bed Authority, in the exploration of polymetallic nodules and in organizing three expeditions to Antarctica during 1981-82, 1982-83 and 1983-84. The third expedition to Antarctica sailed on 3 Decemeber 1983 on a chartered vessel "Finnpolaris" and landed on Antarctica on 27 December 1983.

Oceans are known to contain vast resources of food, minerals and energy. The development of these resources will have a considerable impact on the economy of our country and hence it is essential to develop technologies particularly in the areas which are not easily accessible. The Department is taking a lead in this direction and in the years to come India will become one of the leading countries in harnessing the wealth of the sea.

2. MARINE PROGRAMME HANDLED BY THE DEPARTMENT

The Department has taken rapid steps to enhance the country's capabilities in ocean sciences and has provided inputs to several institutions in the country.

The different areas of work of the Department during the year 1983-84 can be summarized as follows :

(i) Antarctic research :

The seventh continent of the world is a demilitarised, and nuclear-free zone and offers freedom for research. Recent geological surveys have aroused interest of both developed and developing countries of the world to know more and more about the mineral resources of Antarctica and to exploit the living resources of the surrounding seas for the benefit of mankind.

The Department of Ocean Development, in the three expeditions to Antarctica, has collected a lot of information, data and material. India has also become a member of the Antarctic Treaty.

(ii) Living resources :

India with a long maritime history of the exploitation of living resources from the sea, occupies the eighth position in the world for the total annual catch of fish. India has an extensive coastline of nearly 6000 km and a vast exclusive economic zone (EEZ) of about 2 million sq. km. It contributes about 46% of the total exploited living resources from the Indian Ocean.

The marine fish production is contributed by capture fisheries and the intensively exploited areas include the narrow nearshore regions. In the capture fisheries of India the non-mechanised fisheries still remains to be replaced by powered boats. The increase in the fish production obtained especially in the last two decades is attributed mainly to the increase in mechanised boats and planned developmental activities.

Exploration of marine living resources in the open ocean using oceanographic vessels like *Sagar Kanya* is one of the major objectives of the Department. The relevant aspects of the protection of marine life such as the conservation and monitoring of the marine environment are also to be given a high priority.

Another important sector namely mariculture is very inadequately developed. Aquaculture in the coastal zone is practised at present on a small scale largely in the enclosed areas of estuaries and backwaters and in the states like Kerala and West Bengal. The entire mariculture programme needs further strengthening.

Seaweeds form another economically important marine living resources and are used as food, fertilizers and for certain chemicals and pharmaceuticals. Several institutions have initiated programmes on the cultivation of seaweeds on a mass scale. A technique of cultivation on ropes has been developed for *Gracilaria* and *Gelidiella* and *Enteromorpha.* It is, however, essential to standardize the technology of mass culture of seaweeds, so that it could be undertaken by several coastal states.

(iii) Deep sea mining

The last few years have witnessed the development of technologies for the exploration of polymetallic nodules from a depth of nearly 3500 to 6000 metres and the extraction of important metals such as copper, nickel and cobalt from them. This period has also witnessed the development, in the Third United Nations Conference on the Law of the Sea, of the legal and institutional framework in which the exploitation of nodules will take place.

Thus there is an urgent need for India, to collect as much data as possible for identifying a proper site for mining of the nodules. We have completed the survey and a suitable pioneer area has been identified for registration with the Preparatory Commission of the International Seabed Authority.

Associated with the deep sea survey, is the development of submersible technology. The Department is, therefore, working on the feasibility of acquiring a complete transfer of technology for design, fabrication and operation of submersibles.

(iv) Acquisition of research vessels

The Department's research vessel *Sagar Kanya* is the latest addition to our country's cabability for the exploration of the oceans. It is one of the most modern oceanographic research vessels with advanced facilities for working in the field of physical, chemical, [illegible]

and IITs)

(vi) Legal regime

Expertise in the international law is necessary to understand the legal implications of the Conference on the Law of the Sea. Moreover there are legislations to be developed for the conservation of marine environment and control of marine pollution. For its growing activities, the Department has taken steps to start a legal cell.

(vii) Promotion of other activities

During the year, the Department has supported a variety of different kinds of activities and has also provided help to many institutions in organizing symposia, seminars, workshops, exhibitions in different parts of the country.

This Annual Report gives a summary of different activities undertaken by the Department of Ocean Development during the year 1983-84 under the following headings :

3. ANTARCTIC RESEARCH AND TS IMPORTANCE TO INDIA

Antarctica makes a great natural laboratory. Scientific expeditions to Antarctica become important because of the following reasons :

(a) Antarctica is an important location for observing the interaction of the magnetic field in conjunction with the charged particles from the sun.

(b) The North and the South Poles keep the heat budget of the world in balance. The heat transported through the atmosphere and the oceans to the Poles is dissipated in space in the form of long wave radiation.

c) Antarctica is a stable platform for carrying out observations. It is far away from all industrial areas and thus remains an unpolluted datum point from which global changes due to pollution can be monitored.

(d) The glaciers from Antarctica comprise about 90 per cent of the Earth's ice. Thus, Antarctica holds a significant fraction of the fresh water resources of the earth.

(e) The waters from Antarctica support a few species with large populations and are among the richest biological provinces on the earth. The important organism regulating the simple food chain in Antarctic waters is the red shrimp-like krill.

(f) In the mesozoic era, Gondwanaland had a common land mass of five continents, namely Africa, Antarctica, Australia, India and Latin America. Later, the continents drifted away and got separated by water mass. It is for this reason it can be stated that Antarctica

(g) Geologists believe that some rich deposits of coal, iron, uranium, copper, lead, oil, gas etc. are found in Antarctica.

The scientific informations obtained by the Indian expeditions to Antarctica will

I) RESULT OF THE FIRST INDIAN EXPEDITION TO ANTARCTICA

The first Indian expedition to Antarctica left Goa on 6 December 1981 by MV *POLAR CIRCLE,* a chartered ship from M/S G.C. Reiber & Co., Bergen, Norway. The expedition, under the leadership of Dr. S.Z. Qasim, Secretary, Department of Ocean Development landed on the Antarctic continent at 0030 hours (IST) on 9 January 1982. The Indian team had 21 members from seven different institutions of the country and included oceanographers, meteorologists, biologists, geologists, a geophysicist, a radio communication expert and several naval personnel.

A base camp was set up on ice and another in the hilly terrain which was named "Dakshin Gangotri" (Lat.69° 59′ 23.12″ S and Long. 11° 56′ 26.82″ E).

Geological work undertaken included collection of rock samples from three areas, dust debris within the ice slab, age determination of rocks and several other features. A meteorological station was also set up at the base camp to monitor the weather.

Observations relating to radiowave propagation were also made because Antarctica is totally free from any radio noise. Other investigations included the chemistry and biology of the shelf ice. The team penetrated the landmass using helicopters and landed in between the hills where an Antarctic freshwater lake was studied. The unmanned weather station 'Dakshin Gangotri' was established here. A large quantity of indigenous equipment, including communication instruments, batteries, watches, walkie-talkie, cement, clothing and preserved and dehydrated foods were used at the sub-zero temperature for the duration of the stay. The team found all the Indian equipment functioning well. Similarly, the entire weather station at Dakshin Gangotri, which is solar powered and computerised to record the data is entirely of Indian make. A prefabricated wooden refuge hut stocked with food, medicines, fuel, drinks, tobacco, etc. was also put up as per the Antarctic conventions

(a) Position fixing in Antarctica

Antarctica has large desolate areas. It is covered with an enormous volume of ice. It has few land marks and even fewer geodetic marks. Therefore, it offers a great challenge for position fixing in conducting surveys. The weather in Antarctica, accompanied by strong winds and snowfall, also hampers position fixing. In surveys and exploration, very accurate position fixing is a prime requirement for the scientific work. The radio propagation conditions are also not favourable for the operation of radio positioning systems in Antarctica. However, the development of satellite navigation systems in recent years has provided an important tool for position fixing.

The satellite position fixing system provides accurately all the three coordinates (latitudes, longitudes and height). The advantage of the system is that it requires reference only to the satellites and can be used anywhere in the world irrespective of the time of the day or weather. The expedition used a portable land sea satellite position fixing system with least-square and 3D techniques to determine the following positions :

WEATHER STATIONS	LATITUDE	LONGITUDE
1. Dakshin Gangotri	70° 45′ 12.963″S	11° 38′ 13.618″E
2. Base Camp Refuge Hut	69° 59′ 12.672″S	11° 55′ 7.263″E
3. Base Camp	69° 59′ 23.119″S	11° 56′ 26.83″E

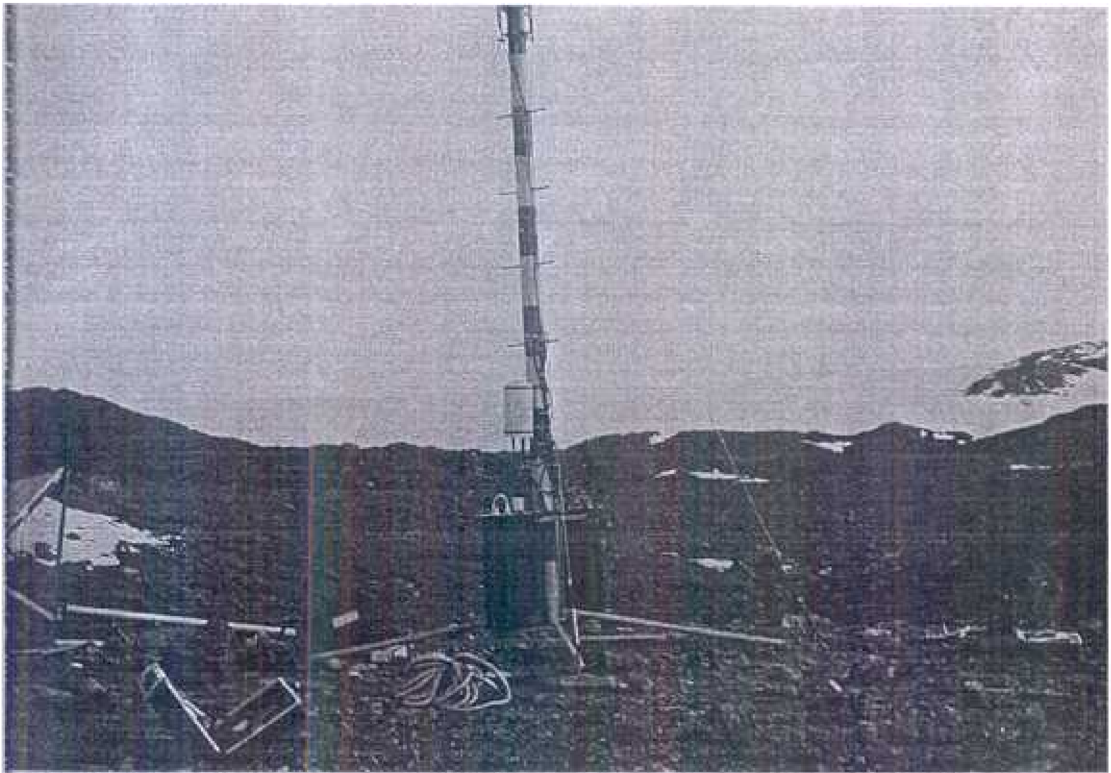
The positions obtained were within a few metres.

(b) The Antarctic weather

Hydrometeorological characteristics of snow and ice along with the radiation balance and computation of melt rate over the Antarctic continent were studied. Similarly, climatic features of the continent were also studied. It was observed that a large quantity of solar radiation (0.5-0.7 1y/min) is received at the surface but more than 80% of it is reflected back in the space. The net radiative heat balance for the continent is positive in the months of December and January while negative in the other months of the year. The net long wave radiation exchange, convective transfer and exchange of the sensible heat contribute negatively to the mechanism of snowmelt during the summer months. The net snowmelt computed by the various physical processes is found to be a few centimetres per day even in extreme summer period. The maximum wind speed observed during the period of expedition was 40 km/hr. A typical phenomenon of inversion mirage on the snow surface was observed during the expedition.

(c) Results obtained from automatic weather recording station in Antarctica

The automatic weather recording station was installed at Dakshin Gangotri. The station was solar powered, computerised and programmed to interrogate meteorological sensors every 2^{13} seconds (2 hours 16 minutes 32 seconds) and recorded their values. The values were stored on an incremental cassette recorder with a total capacity of 2 mega bits equivalent to a 5 month capacity at the set interrogation interval. The electronics was based on Intel's 8085 micro-processor which was programmed to sample each sensor four times and compute an average value. The reference voltages as well as the temperature of the electronics package were also recorded. The analog to digital converter (ADC) used was Intersil's 7107 for its low power consumption and proven performance.



The automatic, solar-powered and computerised weather station at Dakshin Gangotri set up by the first Indian expedition.

Mechanically, the station consisted of a 4 metre long aluminium pipe of 4.5 inch diameter which was mounted on a steel tetrapod and stabilised by 4 stainless steel guy wires. The electronic was based within a 0.5 inch thick black high density polyethylene (HDPE) cylinder of external diameter 30 cm and a height of 60 cm. The intervening spaces were filled with expanded polystyrene foam.

The data recorded on the tape during the short sojourn at Dakshin Gangotri, was retrieved prior to the team's departure and a new tape was loaded. The meteorological values recorded showed good correlation with the values recorded by the Russian station located about 10 km away from Dakshin Gangotri.

The wind speed and direction sensors were mounted at the top of the weather mast on a cross-arm with one sensor at each end. The humidity sensor was a thin film capacity sensor which had a 0% to 100% relative humidity (RH) range with a response time of about 1 second and a fairly linear temperature dependence of 0.05% RH/°C. The temperature measurements were made using an Omega Engineering Inc., thermistor. The sensor was encased in a stainless steel penetration probe tube which was mounted inside the Stevenson's box. A second probe was fixed to the mast close to the ground level to monitor surface temperature.

The data tape of the automatic weather recording station set up by the first expedition was recovered by the second expedition. The station perfomed well and the entire tape showed valuable and consistent data. The temperature records showed progressive cooling with the advance of the Antarctic winter with a minimum recorded temperature of -29°C. The wind data is consistent with the published results of the long term experiments showing winds generally from the South and South-east sectors. The maximum wind speed recorded in the 6 month period of recording time was 85 mph from a southerly direction.

This weather recording station was the first experience to gain some knowledge of the Antarctic winter. From the recorded data, it appears that it was an extremely useful exercise to design and erect pre-fabricated buildings to withstand fully the winter conditions even when these are extreme. The manned station in Antarctica will give us better information and will benefit us a great deal in future.

(d) Radiowave transmission characteristics in Antarctica

The first Indian expedition provided a valuable opportunity to conduct several experiments on radiowave propagation and communication. However, it has been possible to obtain some preliminary results. The studies made were mainly on the high latitude D-region using VLF observation, atmospheric radio noise, VHF TV signal propagation, HF propagation and communication.

(e) Physical oceanography

During the first Indian expedition, expendable bathythermograph (XBT) hydrographic observations were made along the transects through the Southern Indian Ocean and

Antarctica. A wide north-south variation in the physical oceanographic parameters has been noticed along the transects. Maximum sea surface temperatures have been observed between latitudes 6°-10°S and a sharp fall of temperature has been found near the convergence zones particularly between latitudes 40°-50°S. The surface temperatures ranged between 28.7°C and-1.7°C. The depths of the isothermal (mixed) layer in the Antarctic waters to the south of latitude 68°S extended upto as deep as 200 to 400 m, while at other regions, they are found to be within 100 m. The data clearly showed a convergence process taking place around 60°S with Antarctic surface water slipping below and mixing with the sub-antarctic surface water. T-S analysis showed characteristic changes in T-S relations of the Antarctic intermediate water as the distance from the Antarctic convergence increased.

Near the Antarctic continent, a polynya was observed. This zone of water, surrounded by sheets of ice, showed and increase in the surface salinity resulting from the freezing of the surface sea water. XBT traces showed step-like structures with a limited vertical profile suggesting the influence of basal melting of the ice. The increase of surface salinity caused by haline convection from freezing of the sea water has a prominent role in the vertical transport mechanism and the formation of water masses in the Antarctic Ocean.

(f) Chemistry and environmental studies

Chemical studies on the ice shelf, in a freshwater lake and in the polynya were carried out. These studies included salinity measurements, temperature, dissolved oxygen, phosphate, nitrate, nitrite, silicate, calcium, magnesium, potassium, fluoride, bromide, iodide, iron, zinc, copper, manganese, nickel, cobalt, lead and cadmium.

An increasing vertical gradient downwards in most of the constituents was found in the ice. This is probably due to diffusion of salts in the ice and also as a result of somewhat reducing condition of nitrate prevailing in the ice at depths.

Concentrations of most of the elements in the fresh water lake were largely regulated by the melted water coming from the glaciers and surrounding ice, leaching of the materials from the rocks and the evaporation caused during the prolonged summer.

These features indicate that both Antarctica and the high altitudes of the Himalayas have clean and unpolluted environment [redacted]
most reference

(g) Some biological features of the land mass

The occurrence of a petrophilous lichen *Acarospora* sp. and a moss *Bryum* sp. has been reported from Dakshin Gangotri near Dronning Maud Land during the first Indian expedition. The flora of Dakshin Gangotri consisted only of lichens and mosses, which were found to be growing on rocky substrata and in crevices. No other floral elements belonging to any group of plants were observed in this region.

Biotic and environmental characteristics of four fresh-water lakes in the mountain regions of Dakshin Gangotri have also been reported. Waters were found to be highly turbid (750 to 1530 ug/l of particulate matter), thus impending the passage of sunlight to the subsurface region. The essential nutrients (nitrogen and phosphorus) were low but the silicates were very high. The rate of photosynthesis, varying from 0.14 to 0.68 mg $cm^{-3}hr^{-1}$, largely depended on sub-surface illumination. Bacterial counts were also found to be very high (12×10^{4}-$5.9\times10^{6} ml^{-1}$) and the bacterial flora was dominated by *Bacillus, Micrococcus* and *Corynebacterium.*

(h) Biological productivity of the Antarctic waters

Cold water masses, originating in the Antarctic region and moving northwards, are known to affect the hydrographical features of the southern Indian Ocean. These waters are characterised by very low temperatures, high concentrations of inorganic nutrients and are subjected to extreme seasonal changes in the total incident solar radiation falling on the sea surface. Consequently, the phytoplankton production gets restricted to a short period of summer during the year when it is intense.

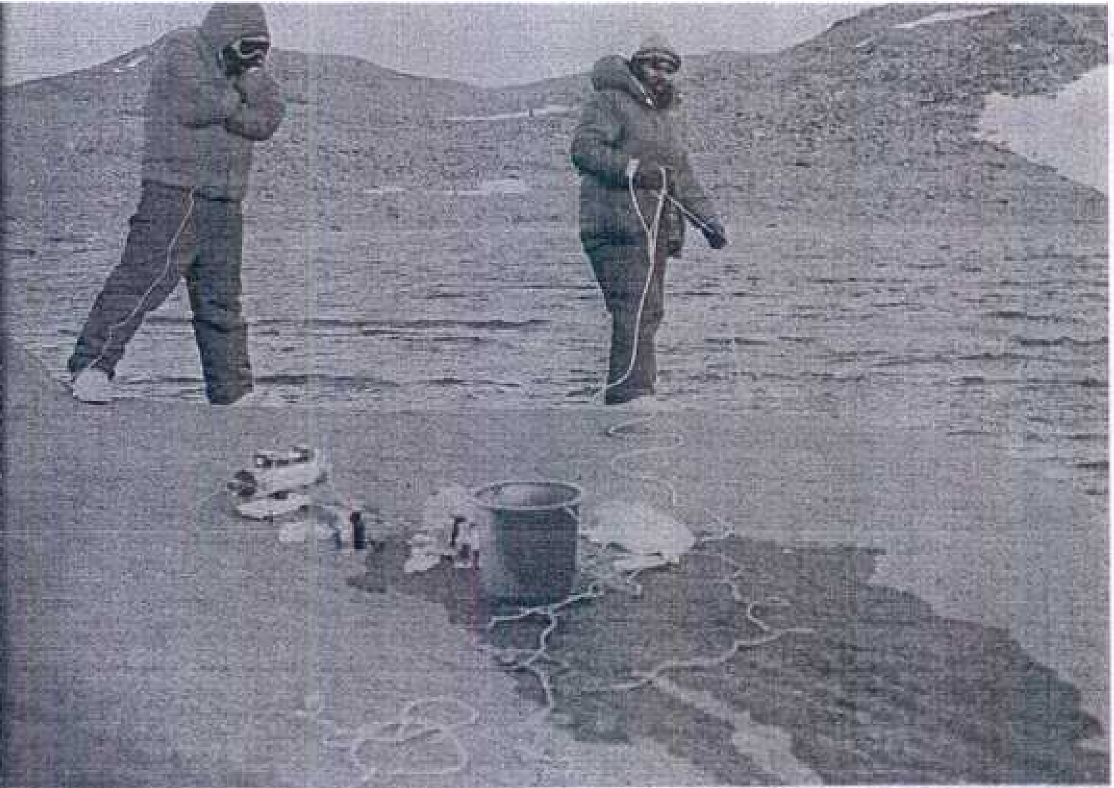
Observations on chlorophyll a, particulate organic carbon (POC) and ATP from the Antarctic waters showed that the chl a concentrations in the shore waters (mean 0.21 mg m^{-3}) were not significantly different from those of the open ocean waters of the Antarctic (mean 0.215 mg m^{-3}). Vertical distribution of chlorophyll a was uniform in the euphotic zone. POC concentrations revealed that the area studied is fertile and there is a regular input of organic material into the water column. A direct relationship was found between the bacterial counts and ATP content. A significant part of POC appears to exist as detritus.

(i) Aerosol particles

Measurement of aerosol particles along a transect in the south-western Indian Ocean showed a gradual decrease in the density particles towards Antarctica. The concentrations [illegible]

(j) Geology, geophysics, geomagnetism and glaciology

The first Indian expedition had collected a large number of sediment samples, rocks, [illegible]



Water samples being collected from a lake in Dakshin Gangotri.

water and ice samples for laboratory studies from the continental margin and adjacent seas off the Princess Astrid Coast, Queen Maud Land (Antarctica).

The foraminiferal fauna of the sediments of the continental margin off Queen Maud Land (except the continental shelf) is dominated by planktonic foraminifera (more than 90%).

The presence of some shallow water foraminifera such as *Legena* and *Oolina* in the deep water has been explained due to ice rafting. The absense of *Uvigerina* a common genera of the sub-Antarctic regions indicates the lack of faunal mixing from the southern Indian Ocean to the Antarctic continental margins.

The scientific work in Antarctica included several programmes of varied nature. The work of geological and geophysical programme included bathymetry, recording by side scan sonar, seismic profiling, magnetics and sea bed sampling.

The sea bed sediments from the 12°E Ridge range form silty clay to sandy silt. The terrigenous component ranges from 72 to 95 per cent and the feldspar/quartz ratio ranges from 0.54 to 2.7. The scanning electron microscopy of quartz shows that the grains near the coast are sharp and angular with conchoidal fractures while the grains away from the coast show V-shaped depressions and rounded edges. The angularity reflects mechanical disintegration and transport by glaciers and ice sheets. The grains were subsequently locked up in the ice which possibly led to the formation of V-shaped depressions later covered by deposition. The predominent clay minerals are illite (73 to 91 per cent), chlorite (8 to 26 per cent) which are typical of the Antarctic sediment.

The Oasis mountains is 'Roche Mountannee' in an otherwise wide expanse of thick ice cover; these can be seen from scores of kilometres off the coast of Antarctica. It is about 20 km in length. Four rock samples from the outcrops of the western part of the Oasis mountain in the vicinity of the Dakshin Gangotri station and rock fragments from the bottom sediments from a depth of 1700 m were studied. The megascopic and microscopic studies revealed that the four rock samples are (1) hypersthene and garnet bearing gneiss (ii) garnetiferous, granitoid gneiss (iii) biotite granite and (iv) amphibolite. The rock fragments are of (i) granoditoritic gneiss and (ii) sillimanite-bearing granulite. The rock samples are similar to that of peninsular India. These are thus related to the pre-drift positions of India and Antarctica.

Magnetic measurements were carried out on Antarctica during the period of first expedition as a part of the programme. The measurements were essentially of an exploratory nature to assess the feasibility of monitoring the magnetic field continuously on a long term basis and to carry out systematic magnetic surveys to study the magnetospheric influences on the terrestrial magnetic field in the continent continously on a long term basis.

Geochemical studies of a sample of metapelite collected during the first Indian expedition were carried out at the geochemical laboratory of the National Geophysical Research Institute by x-ray fluorescence and atomic absorption spectroscopy. Geochemical studies of the metapelite collected from Dakshin Gangotri showed striking similarities to the metapelites of the Napier Complex, Enderby Land Antarctica and khondalites of the Eastern Ghats of India.

A large number of horizontal tilted and overturned icebergs were observed during the expedition. Their estimated thickness varied from a few metres to over 200 m. An examination of the pack ice and the ice shelf around the base camp indicated the altitude of the latter as 44 m. Experiments using carbon black gave average results of the ice melting as 35.8 mm/day (19.7 mm water equivalent). The average natural melting rate was observed as 2.6 mm/day. Studies of the ice core samples showed the presence of nuclear debris. Cosmogenic ^{7}Be occurs at levels of 30 dpm/1. Small amounts of dust, obtained by filtering the melted water, showed the presence of metallic spherules.

(k) Studies of the rock samples from Dakshin Gangotri

Antarctica has long been recognised as an important component of Gondwanaland forming the central locking place in the natural reconstruction of the southern continents. Its geology has many points in common with that of Peninsular India.

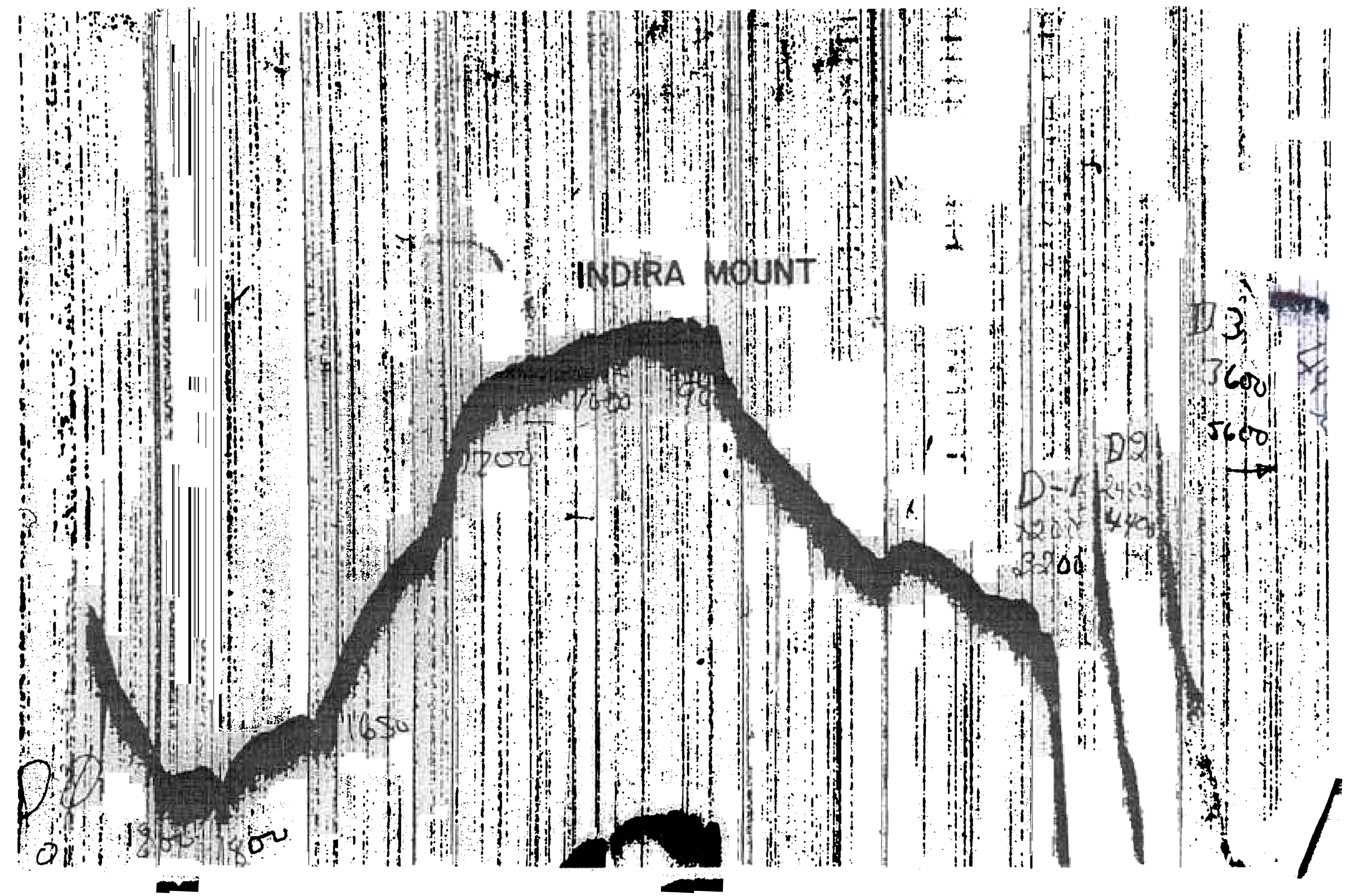
The rock samples collected from Dakshin Gangotri have been analysed for petrography and for major, minor and trace elements. The study reveals that the rock is composed predominantly of plagioclase, quartz, garnet and biotite with minor amounts of microcline, hypersthene, magnetite and accessory apatite and zircon grains.

It has been found to have high SiO_2 (65.38%) and high CaO/K_2O (3.6) and Th/U (30) ratios.

(l) Indira Mount: An underwater mountain in the Antarctic Ocean

The knowledge of depths of the sea is essential for all oceanographic research work. The topography of the seabed, to a large extent, reflects the structure, tectonics and geological history of the seabed. With increasing interest in marine research and surveys, large areas of the seabed have been charted and the bathymetry and morphology of the ocean floor is becoming fairly well known.

During the first Indian expedition, a major topographic high on the seabed at 53° 39.79′ and 47° 55.82′E was discovered. This was named as "INDIRA MOUNT". The mount rises from a depth of about 4500 m to about 1200 m and has a number of peaks. One of these peaks rises upto 880 m below the sea surface The apparent width of the mount at the base appears to be about 185 km and at the summit it is about 134 km. The mount is associated with a composite magnetic anomaly of the order of 1000 gammas The multiple peaks and high magnetic anomalies indicate that the mount is largely composed of volcanic rocks. The discovery of this hitherto unreported seamount will have an impotant bearing on the


INDIRA MOUNT

geological history of the Antarctic Ocean. It is one of highest seamounts ever recorded in any ocean of the world.

(II) SECOND INDIAN EXPEDITION TO ANTARCTICA (1982-83)

After the successful completion of the first expedition, the Department organised the second expedition to Antarctica.

A 28-member team was selected from several different organisations of the country. It was led by Shri V.K. Raina, Director in the Geological survey of India. The expedition left Goa on 1 December, 1982 and successfully landed on Antarctica on 28 December, 1982.

The objectives of this expedition were :

(i) to select a site for a permanent station.

(ii) to carry out various scientific research activities.

(iii) to establish a communication link with India.

(iv) to prepare an air strip for aircraft landing.

(v) to carry out reconnaissance of the area up to 100 km from the base for future work.

The following work was carried out by the team :

Logistics

(a) The stay on Antarctica during the first expedition was for a total duration of 10 days. This was too short a duration for carrying out extensive scientific research on land. The second expedition stayed on the landmass for a period of 57 days.

(b) It surveyed the area and selected a site for setting up a permanently-manned station. It established a base camp on the landmass. It recovered the cassette from the automatic weather-recording station left behind during the first expedition and fixed a new cassette after fully overhauling the entire system.

(c) It worked out the logistics for setting up and servicing a permanently-manned research station. For this purpose, it carried out a detailed assessment of the annual requirements of manpower, stores, equipment and services for the permanently-manned station to be operative during 1983-84 season.

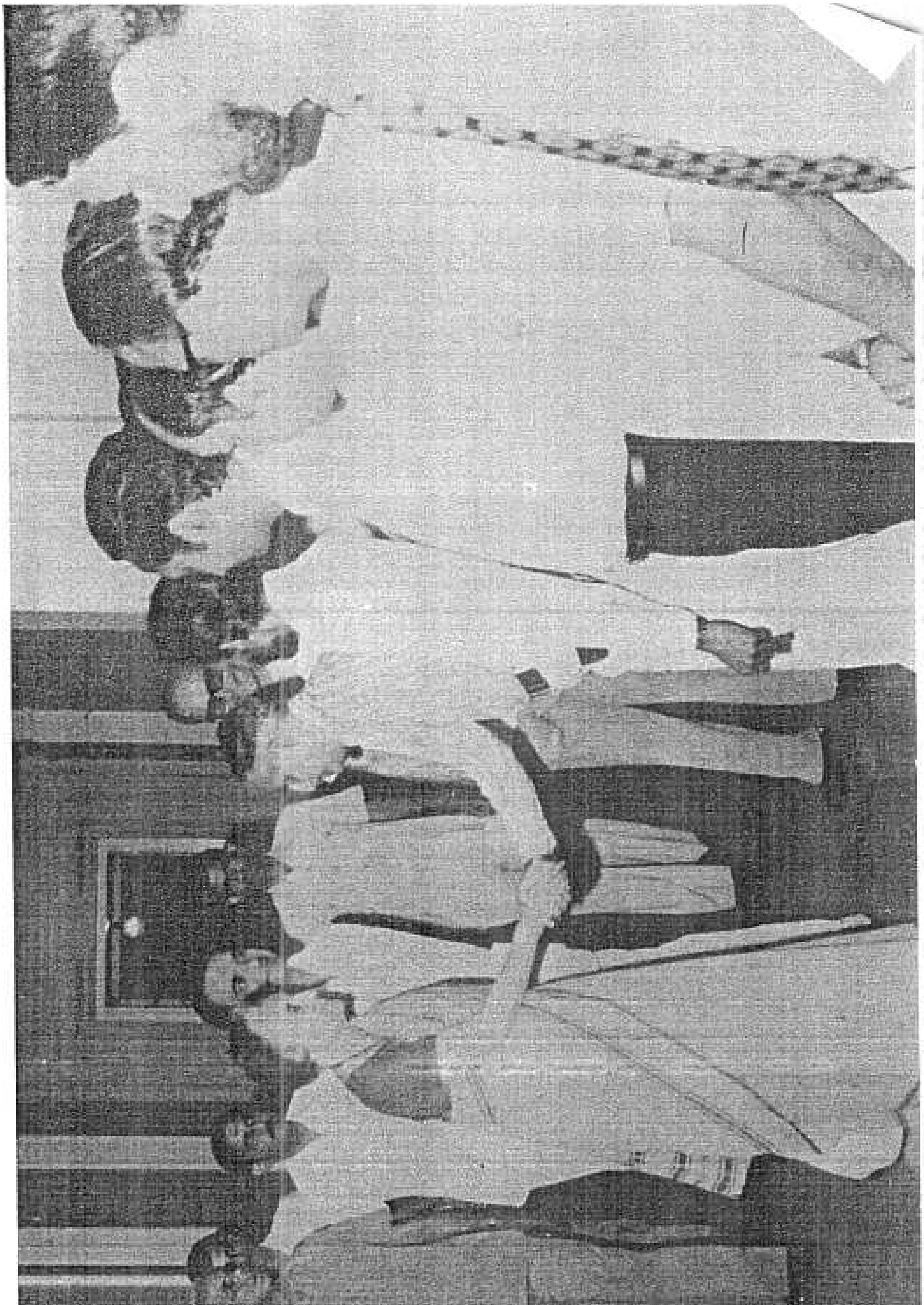
(d) It surveyed and identified an area for a suitable airstrip and prepared it for landing of an aircraft.

(e) It established a direct communication link between the base camp on Antarctica and India as also between the base-camp and the mobile parties on the land-mass and the ship.

Scientific

(a) Geological studies :

Geological mapping of an area of 4.5 square kilometres on 10000 scale, in the



The Prime Minister of India being introduced to the leader of the second expedition team.

The Prime Mi of India th the ıbeı nd ped
Minister of Sta hri Sh

Dakshin Gangotri range (Lat. 70°45′ 12.9″S, Long . 11°38′ 13.6″E) was completed wherein the nature of the various rock outcrops and structural disposition were plotted.

A geological reconnaissance of the Wohlthat Mountains around Lat.71° 18′S and Long. 13°31′E was also carried out. The Wohlthat Mountain range can be divided into massifs with south to north trending glaciers emerging from the inland polar ice and the range of exposed rocks of metamorphic and volcanic origin.

(b) Snow and ice studies :

Studies were carried out near the base camp and far inland upto Dakshin Gangotri Hills. These studies covered the recording of (a) snow accumulation and ablation at the shelf (b) changes in the surface microrelief of the shelf ice (c) nature of movement along the crevasses within the shelf ice (d) experiment on artificial augmentation of ablation of the shelf ice (e) thermal profile of the shelf ice (f) crystal studies on the ice (g) snow stratigraphy and density profiling of the polar and shelf ice (h) studies on the iceberg flow drift and stratigraphy.

In addition, a map of the Dakshin Gangotri glacier was prepared, marking the terminal of the ice front. Ice core samples were also collected from this region for dating purposes.

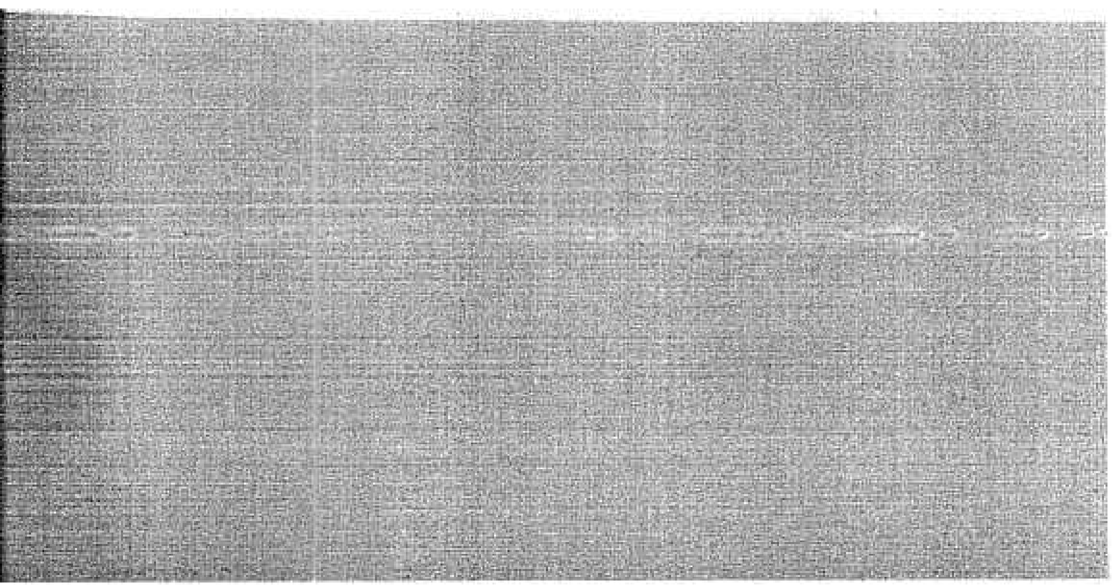
(c) Meteorological studies ;

In all, 55 balloons were launched in Antarctica which included 8 low level sondes, 6 ozone sondes, 10 omega sondes and the rest were radiosondes. Of these, 50 soundings were successful and yielded valuable data. Lowest temperature recorded was −15°C and the highest was +8°C. However, the average temperature was well below zero most of the time ranging between −5° to −10°C. Winds had a particular pattern of fluctuations with the spells of calm interspersed between the spells of high winds. There were many clear days in January but cloudy spells increased during February both low and medium clouds were present in February. Excellent visibility prevailed most of the time (upto 10 km) but during the storms it was reduced to 50 metres. Strong reflection of solar radiation from the snow was the most interesting feature of the radiation measurements. Spectral measurements in UV band showed no significant attenuation of UV in the reflected solar radiation. Temperature under the snow showed a steep gradient going down to-13.5 at 20 feet. The sharpest gradient existed between the first 10 feet under snow. Diurnal variations were found to be negligible.

(d) Radiowave propagation studies :

VLF propagation experiments consisted of recording the VLF/OMEGA signal phase and the amplitude. Phase measurements were carried out with respect to an atomic frequency source. VLF experiments had also been carried out during the first expedition and some conclusions were drawn regarding the quiet time solar zenith angle dependence of the D-region electron density. With more and extensive data now available, these conclusions were confirmed.

A view of the barrack erected at the Indian camp in Antarctica.



Riometer experiments consisted of continuous recording of the extra terrestrial cosmic noise along the local zenith on two frequencies (20 and 30 MHZ). The analysis of the cosmic noise variations will yield quantitatively the nature of the lower ionospheric variations during the quiet time as well as during the geomagnetically disturbed conditions. Several cosmic noise absorption events have indeed been recorded. These events correlated very well with the poor, long distance HF reception (from COMCEN Bombay).

(e) Air-sea interaction studies :

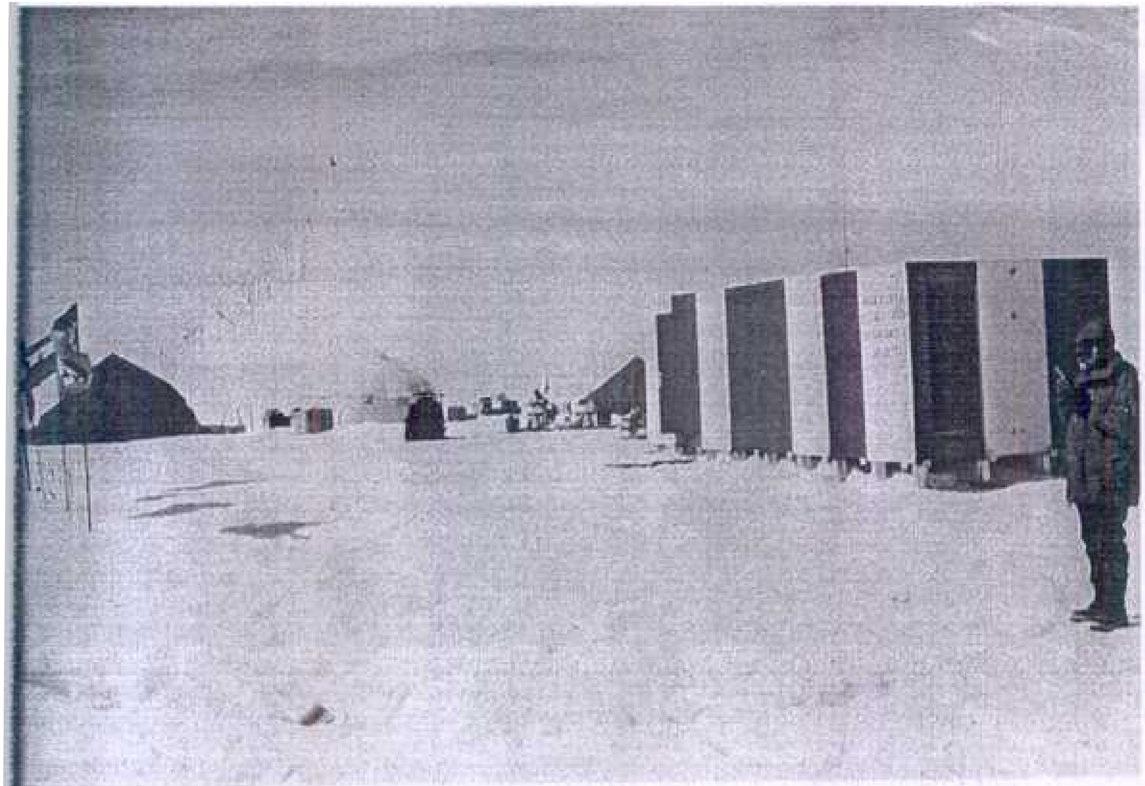
A continuous set of observations was made on the temperature at the sea surface and at a level of 40 feet of humidity at the 40 feet level, and of the wind speed and direction at the same (40 feet) level. A computer programme has been developed to compute the various heat flux terms. It is proposed to compare the heat flux computation as outlined above with the semi-theoretical model calculations worked out earlier.

(f) Microbiological and biological studies :

Bacterial counts were taken from the shelf ice (at 5 stations) melt water (at 3 stations) and from the ice core (0m, 0.5m, 1 m, 1.5m, 2m) taken from the ice shelf near the Indian base camp. Ice incubations were done to measure the productivity potential from the 13 samples collected from the shelf ice. Bacterial counts were taken from the 5 ice samples and one

(g) Geophysical studies :

Magnetic survey (measurement of the total intensity of the earth's magnetic field) was



A view of the Indian camp at Antarctica. In the foreground is the prefabricated shelter designed by CBRI, Roorkee.

conducted over a small part of the Antarctic region using proton precision magnetometer. The details of the survey are :

[redacted]

(h) **Material for paleomagnetism and magnetic properties :**

Fifty rock samples were collected from ten different sites at Dakshin Gangotri for the determination of paleomagnetism and magnetic properties.

(i) **Acoustic and hydroacoustic studies :**

Noises produced by the ice cracks in the pa [redacted]
ice were recorded both through ice and air. [redacted]
sound was also studied by recording diurnal [redacted]
four hours.

[redacted]

(k) **Hydroacoustic studies relevant to sonar :**

[redacted]

(l) **Geomagnetic studies :**

The strength of the total geomagnetic field 'F' at the base camp (Lat. 69° 59′S Long. 11°55′E) was recorded continuously using a proton magnetometer. Measurements were made every 10 seconds with a sensitivity of ± 1 gamma. The three vector components of the geomagnetic field viz. northward, eastward and vertical (X, Y, Z) were individually recorded. The vertical component 'Z' of the geomagnetic field was measured regularly using a direct reading digital fluxgate magnetometer. Observations of the strength of the total geomagnetic field 'F' were made at the Dakshin Gangotri camp (Lat. 70°45′S Long. 11°38′E) as well as around the ice shelf at the base camp. VHF signals at 244 MHZ from the geostationary satellite were also recorded.

A view of the Indian camp at Antarctica after a blizzard hit the camp at 150 kilometres per hour.

(m) Indian manned station in Antarctica:

It is proposed to set up a manned station at Antarctica in the year 1983-84 to hav continuous scientific observations all the year round.

(n) Participating institutions during the second expedition:

The members of the team for the second expedition were selected from the followin organisations:

1. Geological Survey of India
2. National Physical Laboratory
3. India Meteorological Department
4. Indian Institute of Geomagnetism
5. National Geophysical Research Institute
6. Naval Physical and Oceanographic Laboratory
7. Ministry of Information and Broadcasting
8. National Institute of Oceanography
9. Bharat Electronic Limited
10. Indian Air Force
11. Indian Army
12. Indian Navy.

(III). THIRD INDIAN EXPEDITION TO ANTARCTICA (1983-84)

The Department has sent a third expedition to Antarctica to carry out more intensive research activities on the frozen continent and to set up a manned station in Antarctica.

A team of 83 persons which included 2 women scientists was chosen from different organisations of the country. Dr. H.K. Gupta, Director, Centre for Earth Sciences Studies (CESS), Trivandrum was selected as the leader of the expedition, and Lt. Col. S.S. Sharma of the Defence Research and Development Organisation as the Deputy Leader.

The third expedition left Goa by a specially chartered finnish vessel "Finnpolaris" on 3 December 1983, and landed on Antarctica on 27 December 1983. About 12-15 members of the team are likely to stay on in Antarctica for the whole year. The scientists staying back would continue experiments even during the six-month long Antarctic winter when the continent is in total darkness. During this period, the team will keep in touch with the Department via the satellite channel.

The main task of the third expedition would be to set up a permanently-manned station in Antarctica. The ship "Finnpolaris" is carrying prefabricated building material and specially designed containers to expand the existing Indian barracks erected during the earlier Indian expeditions. Four helicopters will carry men and materials from the ship to the camp on Antarctica.

The ice-breaker-cum-supply vessel "Finnpolaris" chartered from Finland for the third Indian expedition to Antarctica.

India's permanent station is likely to have all the facilities for protection in the hostile cy environment including living, working and storage accommodation, entertainment centre, ice melting plant, electricity generating unit, satellite link with India, etc.

The permanent station would accommodate about 15 persons (scientists and support personnel). The manned station in the Antarctic will be established only after providing all the safety and logistics facilities. Logistics in later years would require an air-strip close to the camp to maintain the supply of materials and evacuation of persons if an emergency situation arises. The Indian Air Force is engaged in the task of identifying a suitable aircraft

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A. Objectives of the third Antarctic expedition:

Logistics

(a) It will carry out a quick survey of the area to ensure that the site selected for the base camp by the second expedition is stable and capable of taking the weight of the proposed structures.

(b) It will erect the building for the permanent Indian station and equip it with all essential services like power, water supply, heating, sewage disposal, etc.

(c) It will establish direct communications link between India and the station in Antarctica.

(d) It will test the reliability of the structures and other essential equipment for a period of 6 to 8 weeks. If these are found to be satisfactory, a team of 12 to 16 persons will be left behind for wintering in Antarctica.

Scientific

Work started in various scientific disciplines during the first two expeditions will be continued. Studies will *inter alia* be carried out in the following disciplines.

(a) **Environment:** Work on aerobiological sampling will be continued and investigations on the effect of man-made changes in the Antarctic environment will also be studied.

(b) **Meteorology:** Four sub-stations within an area of about 100 sq. kilometres will be established and these sub-stations will be linked with the main station for bringing out weather forecasts. Ice-charts will also be prepared and released periodically using all types of data and satellite pictures. The automatic weather station at "Dakshin Gangotri" set up during the first expedition, will be examined and serviced and the second cassettes will be retrieved. The system will be overhauled and updated.

(c) **Geology:** Investigations on the rock and ice samples will be continued.

Large helicopter, MI-8 of the Indian Air Force landing on Finnpolaris. Two of these helicopters are being used for the first time in Antarctica.

(d) **Geophysics:** Experiments will be carried out to confirm whether the ice cover 'here our permanently-manned station is to be established this year is on the land mass or n water.

(e) **Terrestrial life of Antarctica:** Collection of the primitive form of life occurring in ıntarctica will be continued.

(f) **Oceanic studies:** These will include intensive investigations on physical, chemical nd biological oceanography at some selected stations of the Antarctic Ocean and along the ntarctic coast. In addition, further investigations will be conducted on krill as a food :source in the Antarctic waters under the title "Biomass"-Biological Investigation on Iarine Antarctic Systems and Stocks. Microbiological studies on the Antarctic waters ıd ice will be continued.

(g) **Other studies:** Earlier studies on communication have yielded valuable information ıd hence further data on signal strength and frequency transmission will be collected. milarly, in the other fields in which the work has remained unfinished, will be undertaken rther or completed.

B. Team members of the third Indian scientific expedition to Antarctica

l. o.	Name	Organisation
1. Leader	Dr. H K Gupta	Centre for Earth Sciences Studies, Trivandrum
2. Member	Dr. (Miss) Aditi Pant	National Institute of Oceanography, Goa
3. Member	Dr. (Miss) Sudipta Sen Gupta	Jadavpur University, Calcutta
4. Member	Dr.K.J. Mathew	Central Marine Fisheries Research Institute, Cochin
5. Member	Dr. Madan Lal	Oil & Natural Gas Commission, Dehra Dun
6. Member	Dr. A K Bakhshi	Delhi University (ARSD College) Delhi
. Member	Dr. L S Rathore	India Meteorological Department, Pune
. Member	Dr. Ashutosh Singh	Amateur Radio Associations, New Delhi
. Member	Dr. A K Hanjura	National Physical Laboratory, New Delhi
Member	Shri SWA Naqvi	National Institute of Oceanography, Goa
Member	Shri M R Nayak	-do-
Member	Shri M Manoharan	-do-

13. Member	Shri R.K Singh	Geological Survey of India, Lucknow
14. Member	Shri J M Vartak	Ministry of Information and Broadcasting, New Delhi
15. Member	Major P K Nair	Indian Army
16. Member	Capt. H C Lohumi	-do-
17. Member	Capt. A Harnal	-do-
18. Member	Capt. AS Patil	-do-
19. Member	Capt. A T Patnaik	-do-
20. Member	Nb Sub P L Dwivedi	-do-
21. Member	HMT Malkhan Singh	-do-
22. Member	Hav. Shiv Kumar	-do-
23. Member	Hav. R. Reddy	-do-
24. Member	Nk R Francis	-do-
25. Member	Nk Dayal Singh	-do-
26. Member	L/Nk S. Sekar	-do-
27. Member	Hav BV Subraya	-do-
28. Member	Hav Jit Ram	-do-
29. Member	Nk Jagtar Singh	-do-
30. Member	L/Nk A Suregaonkar	-do-
31. Member	L/Nk Govind Raj	-do-
32. Member	L/Nk Baldev Banger	-do-
33. Member	L/Nk Thimmiah	-do-
34. Member	L/Nk Gopal Reddy	Indian Army
35. Member	Spr Devasagayam	-do-
36. Member	Nk Gajanan Jadhav	-do-
37. Member	Hav Shamsher Singh	-do-
38. Member	L/Hav Mohan Kumar	-do-
39. Member	Hav K G Subramani	-do-
40. Member	Nk Balwant Singh	-d0-
41. Member	Capt. G P Krishnamurthy	-do-
42. Member	Spr K G Pillai	-do-
43. Member	Nb Sub J S Kalliraman	-do-
44. Member	Cdr. VP Sathiamoorthy	Indian Navy
45. Member	Lt. Cdr. R S Gill	-do-
46. Member	Cdr. S K Chandana	-do-
47. Member	Lt. Cdr. R S Chauhan	-do-
48. Member	Lieut M S Khela	-do-
49. Member	Lieut A A Khan	-do-
50. Member	AA3 P K Balakrishnan	-do-
51. Member	Poelar R.K. Kapoor	-do-
52. Member	AL3 H Singh Mech	-do-

53. Member	C K "0" D Sebastine	-do-
54. Member	C K "0" C V Gopal	-do-
55. Member	Wg. Cdr. R S Tandon	Indian Air Force
6. Member	Wg. Cdr. R D Madhok	-do-
7. Member	Wg. Cdr. V Natarajan	-do-
8. Member	Flt. Lt. Ajit Kumar	-do-
9. Member	Flt. Lt. V M Khanna	-do-
0. Member	Flt. Lt. N M Rai	-do-
1. Member	Sq. Ldr. K I Trivedi	-do-
2. Member	Cpl K N Mandal	-do-
3. Member	Sgt. Joseph Mathew	-do-
4. Member	Sgt. Vishwakarma	-do-
5. Member	Sgt. S B Gupta	-do-
6. Member	Sgt. A B Jagdev	-do-
7. Member	Sqn. Ldr. S K S Puri	Armed Forces Med. Service
8. Member	Major B K Singh	-do-
9. Dy. Ldr. and Stn. Comdr.	Lt. Col. S S Sharma	Defence Research & Development Organization
0. Member	Dr. S R H Rizvi	India Meteorological Department, Pune
Member	Shri S G P Matondkar	National Institute of Oceanography, Goa
Member	Capt. R R Sinha	Indian Army
Member	Capt. Ram Kumar	-do-
Member	Nb Sub S Joseph	-do-
Member	Nb Sub V S Rana	-do-
Member	Hav Padmanabhan	-do-
Member	L/Nk S Thambi	-do-
Member	L/Nk S Sadekar	-do-
Member	Capt. Parmjit Singh	-do-
Member	Sug. Lt. Com. Aloke Banerjee	Armed Forces Medical Services.
Member	Lt. Cdr. N P Singh	Indian Navy
Member	Mr Karl Kesseler	M/s K Kassbohrer, F.R.G.
Member	Mr. David Williams	M/s Structaply Ltd, U.K.

) INDIA JOINS THE ANTARCTICA TREATY

Ever since the first Indian expedition returned from Antarctica, the Government of India been considering the various implications of joining the Antarctic Treaty. After efully evaluating the various advantages and disadvantages, a decision was taken that it ald be desirable for India to accede to the Antarctic Treaty. Thus an Instrument of

Accession signed by the President of the Re public of India was deposited with the Depository Government, the United States of America in Washington D.C. on 19 August 1983 and India became a member of the Antarctic Treaty.

The salient features of the Treaty are :-

(a) that Antarctica should be used for peaceful purposes only and that all military activities should be banned in Antarctica;
(b) that Antarctica should be a totally nuclear-free zone and that no nuclear tests of any kind should be permitted there;
(c) that cooperation and exchange of information in scientific research should be encouraged;
(d) that protection should be given to the vulnerable natural environment of Antarctica;
(e) that all territorial claims should be frozen in Antarctica.

The decision by India to join the Treaty was largely based on the following considerations :-

(i) that India would be able to exchange scientific information with other members of the Treaty and thereby enhance its analytical capabilities;
(ii) that if elected, India would be able to participate in the meetings of the Consultative Committees and in doing so will effectively project her own views as well as those of the non-aligned countries of which India is presently the Chair-person, and
(iii) that India will be able to participate in the ongoing discussions on the resources of Antarctica and ensure that any regime set up is in harmony with India's overall policies and objectives.

(V) INDIA ELECTED AS MEMBER OF ANTARCTICA CONSULTATIVE COMMITTEE

On 12 September 1983, that is within one month after accession to the Treaty, at the Fifth Special Consultative Meeting of the Antarctic Treaty held in Canberra, the Notifications of India on its entitlement to participate as a full Consultative Member in the Consultative Meetings of the Antarctic Treaty, was considered. The 14 representatives of the Consultative Parties namely Argentina, Australia, Belgium, Chile, France, Federal Republic of Germany, Japan, New Zealand, Norway, Poland, Republic of South Africa, U.K., U.S.A. and USSR, acknowledged by consensus that India has adequately fulfilled the requirements established in the Article IX, Paragraph-2 of the Antarctic Treaty and as a consequence, the country was entitled to become a Member of the Consultative Committee

Thus India achieved the previlege of becoming the Fifteenth Consultative Member of the Antarctic Treaty and consequently India's image and prestige was considerably enhanced in the international community.

(VI) INDIA ATTENDS XII ANTARCTICA CONSULTATIVE TREATY MEETING

A delegation of India participated in the XII Consultative Committee meeting held in Canberra, Australia from 13 September to 27 September, 1983.

The XII Antarctic Treaty Consultative Committee Meeting began on 13 September 1983. India participated for the first time in such a meeting. The meeting was also attended by delegations from the Acceding States which did not hold consultative status.

[redacted]

4. DEEP SEA POLYMETALLIC NODULES-THEIR EXPLORATION AND USEFULNESS TO INDIAN SUBCONTINENT.

The increasing population growth of the world has prompted the scientists from all over the world to seek new sources of raw material and food. Today, we are looking for more and more resources into the vast oceans to satisfy our rapidly increasing demands for food, freshwater, minerals and energy. India and many other countries are already exploiting oil, gas and other valuable minerals from the sea floor.

The ocean floor is known to contain very large deposits of minerals, some of which are of considerable economic importance. The exploitation of several of these has already started in many countries including India.

An underwater camera with flash lighting arrangement being lowered to the deep sea for photographing polymetallic nodules.

Mining is largely being carried out from the continental shelf areas up to a depth of 200 metres. These areas are normally found to contain detrital sediments such as sand, gravel and mud. However, from some areas, large deposits of minerals such as phosphorites are also obtained. These shelf areas have also been found to contain oil, natural gas, gold, alluvial diamonds, tin, sulphur, etc.

The floor of the ocean particularly that of the Pacific and Indian Oceans have very large reserve of polymetallic nodules which contain, besides manganese and iron, valuable metals such as copper, nickel, cobalt, zinc, lead, molybdenum, cadmium, vanadium, titanium etc. The economic potential of some of these elements in the polymetallic nodules appears to be so high that even mining of some of them, either alone or in combination is [redacted]

(b) **India's interest :**

Today India exports significant amount of manganese ore but this situation may not last for more than 25 years at the present rate of world production and consumption. The position with regard to nickel, copper, cobalt is also not satisfactory. A large portion of the country's requirement of copper and almost the entire requirement of nickel and cobalt are imported. The UN studies also indicate that land reserves of manganese, nickel, copper and cobalt are modest as compared to the potential reserves found in the polymetallic nodules.

It is with this background that efforts were initiated in the country by the Department of Ocean Development and CSIR for a systematic scientific study of polymetallic nodules and their resource potential

[redacted]

A photograph showing a thick carpet of polymetallic nodules on the seabed at 5000m depth in Central Indian Ocean.

The Indian research ship, *R.V. Gaveshani* during a cruise in the Central Arabian Sea Basin made an important beginning by collecting the nodules from the deep sea. It was an important achievement in the sense that it provided a foundation for further exploration and development of future technology for exploitation. Nearly 3 million square kilometres were initially surveyed using *Gaveshani* and two chartered vessels. From this area, two mining sites of one thousand five hundred square kilometres each were identified for registration. These sites are of equal commercial value.

(d) Mining of polymetallic nodules

Several methods, based on dredging techniques, have been used for mining the nodules from the deep sea. Of these, the following three are known to be economically important.

(i) Hydraulic system

(ii) Air lift system

(iii) Continuous line and bucket system

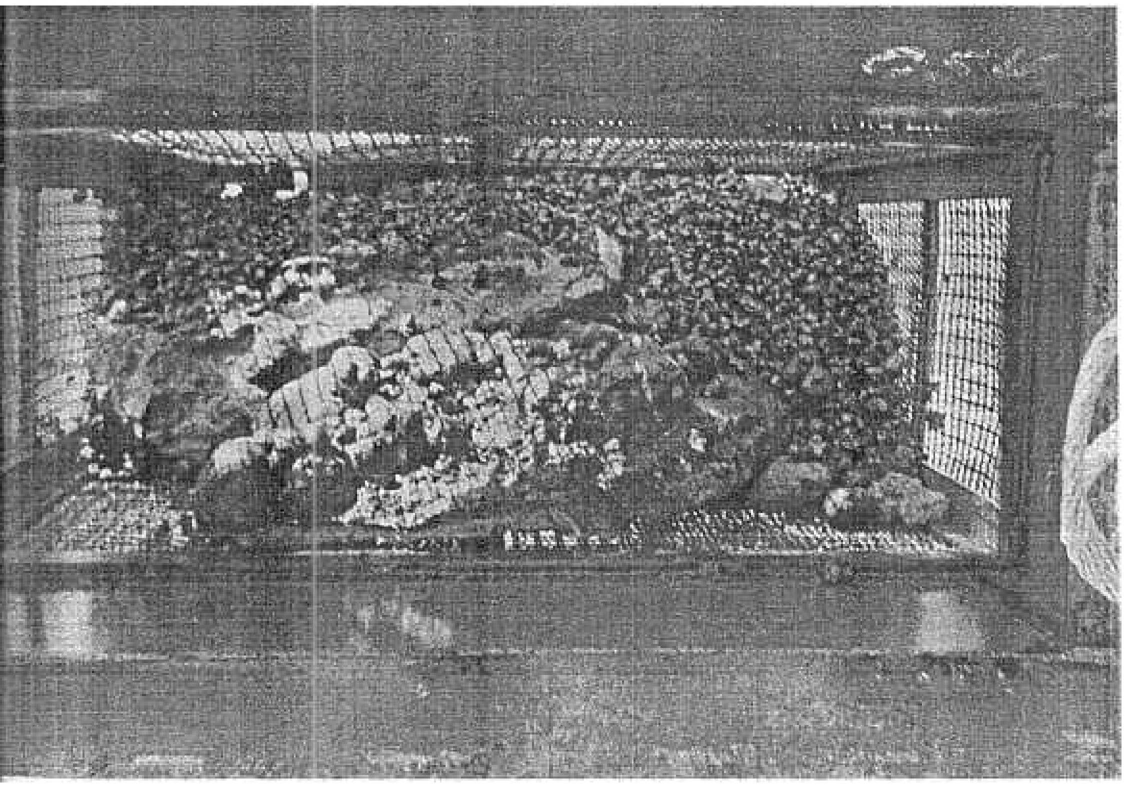
Mining of nodules from the seabed involves a number of problems which are to be evaluated very carefully.

During large scale mining, the water masses are likely to move in all directions thereby stirring and redistributing the sediments on the ocean floor. For environmental protection. it is necessary that the ocean floor should not be disturbed too much so that the growth of the nodules may continue. It is also necessary that careful assessment be made for the technology to be used, risks involved in the mining operations and the total cost of the complete operation.

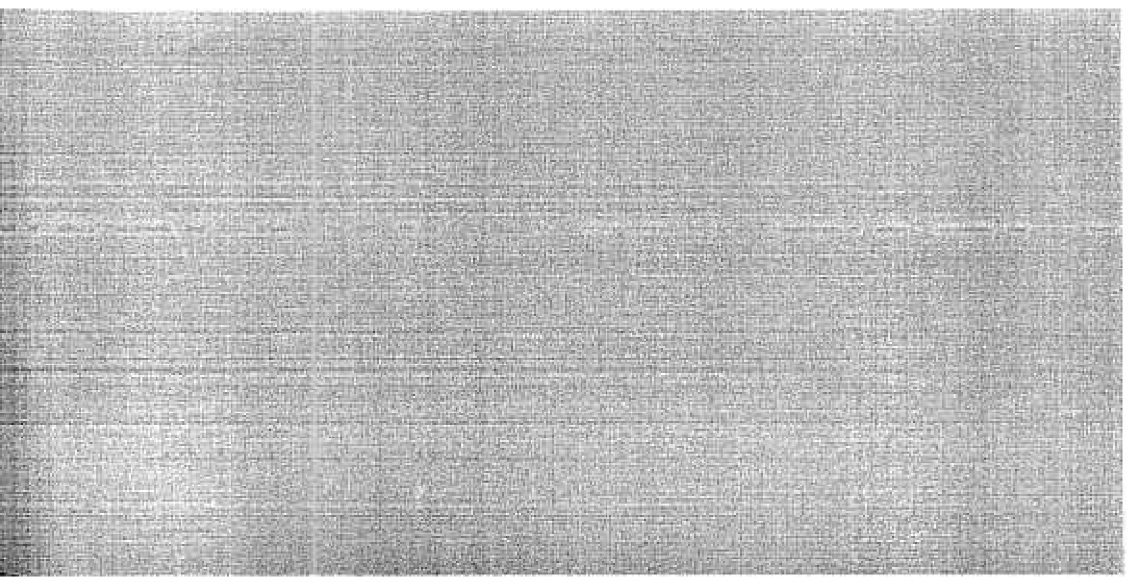
The Department is finalising a comprehensive project for the survey, mining and metallurgy of polymetallic nodules including the economic feasibility of the project.

India, having foreseen the potential in this field, has concentrated its R & D efforts to advance our knowledge and develop the required expertise during this decade. A large number of laboratories and organisations having complementary skills have been involved in the gigantic task of software development and prospecting for the resources in the Indian Ocean. As a result, India is the only developing country in the world which has been named "Pioneer Investor" along with three other developed countries and seven multinational consortia, by the Third United Nations Conference on the Law of the Sea. This will entitle India to register with the Preparatory Commission (Prepcom) of the International Seabed Authority for the exploitation of nodule resources which are beyond the territorial or economic limits of any country.

We have recently completed the survey and have located a suitable "Pioneer Area" for registration with the Prepcom. An application on behalf of the Government of India has already been submitted to the Prepcom for registration of the pioneer area in the name of the Department of Ocean Development which has been appointed by the Government of India



A single dredge haul of polymetallic nodules weighing several kg from the Central Indian Ocean.



as the "Pioneer Investor". During the year, further extensive surveys at closer spacings have been carried out and some environmental data have also been collected with a view to defining the parameters for the design of mining system and for the development of improved prospecting techniques. The survey work involved about 900 ship days. This is likely to be continued further during the coming years, as the collection of environmental data would be necessary even after the mine site has been allotted to us by the Prepcom.

Samples of polymetallic nodules, collected during the year, have also been analysed and a laboratory scale method has been attempted for the efficient recovery of metals from the nodules (copper, nickel and cobalt). The results obtained so far are required to be further pursued at a pilot plant level, before developing a commercial scale plant design. As our current knowledge indicates, the process plant is likely to cost about 65% of the total annual operation cost of the scheme and hence optimising the recoveries and minimizing the operational costs for the process plant are of paramount importance.

Technologically, the most critical area in our developmental effort is the design of the collector used in the mining system. The collector system is required to :

(a) ride on the surface of the ocean floor, penetrating only slightly into the sediment, which may have variable properties;
(b) pick up the nodules imbedded in the sediment at an effecient rate
(c) separate the nodules from the sediment and get rid of as much silt as possible, thus increasing the efficiency of the vertical transport system; and
(d) feed the material to the entrance of the vertical lift system.

Basically the functions of all the systems designed in the collector mechanism have to be highly reliable because of the remoteness of the device. Lifting systems require sufficient power and have to work at depths and at great hydrostatic pressure, and under variable seabed-water interphase layers and with variable current speeds in different layers of the overlying water. A 1000 HP electric motor required for the hydraulic lift system at a depth of 1000 metres will require a cable of the thickness of human arm. The complexity of these systems, therefore, requires an extensive R & D effort to make an inspection of the various developments already available on the international scene and to expedite the development of the most efficient design. Efforts in this direction, planned to be undertaken during the next few years, will prove to be most valuable.

[redacted]

submersible allows the scientist to undertake measurements and to accomplish the various types of work in excellent and safe conditions.

The Department has, therefore, considered the feasibility of acquiring a complete design, fabrication and operation of submersibles. Action has already been initiated to acquire one submersible to be manufactured abroad with full participation of our engineers in its design and fabrication and to manufacture the second submersible in India with our trained engineers with the overall guidance and supervision of the collaborating agency. As per the plans envisaged, the first submersible should become available in the country in 1985.

(f) India's contribution in the meeting of Preparatory Commission of International Seabed Authority:

The resumed Session of the Preparatory Commission was held for four weeks at Kingston, Jamaica from 15 August to 9 September 1983. The agenda of the session included the adoption of the rules of procedure of the Preparatory Commission, the organisation of work and the consideration of matters contained in Resolution II relating to Pioneer Investors. The Commission was also required to finalise the structure of the Preparatory Commission, the composition of its general committees, the structure of all its organs and the election of its officers.

The Preparatory Commission also elected officers for the plenary and the special commissions. India was elected Vice-Chairman of the Commission.

5. WAVE ENERGY AND RELATED ACTIVITIES AT THE OCEAN ENGINEERING CENTRE, IIT MADRAS SPONSORED BY THE DEPARTMENT OF OCEAN DEVELOPMENT

Wave energy potential for the Indian coast is not as high as in the countries located in the northern latitudes Therefore, a wave energy system purely to generate electricity from the waves may not be commercially viable at least in the near future. However, there are many other benefits that may arise by regulating the waves. A multipurpose wave regulator system has been proposed with the following objectives :

To absorb the energy of the waves by providing a long wave barrier and to convert the energy into electricity.

The long barrier results in a calm pool between the barrier and the shore and this pool could be used as :

(i) a natural harbour (ii) space for aquaculture (iii) space for coastal transport using lighter crafts

Such a wave absorbing system provides shore protection against erosion by the waves.

Because of the multi-functional aspects of the wave regulator system (WRS), such system has to be not very far from the shore. It is being proposed to place this system at a water depth of about 10 metres, which occurs at a reasonable distance from the shore. Such locations exist off Madras and at many places along the Indian coast.

A project entitled 'scientific investigation of the wave climate, wave regulation and power has been sanctioned by the Department of Ocean Development for a period of 3 years from July 1982.

The major aims of this project are :

(i) to gather systematic data of the wave climate off the Indian coast;

(ii) to study the various possible designs of wave energy devices, and

(iii) to select the most suitable system for the Indian conditions and suggest a suitable design for its installation at a specific site off the Indian coast. Ten scientific officers are at present working full time on this project.

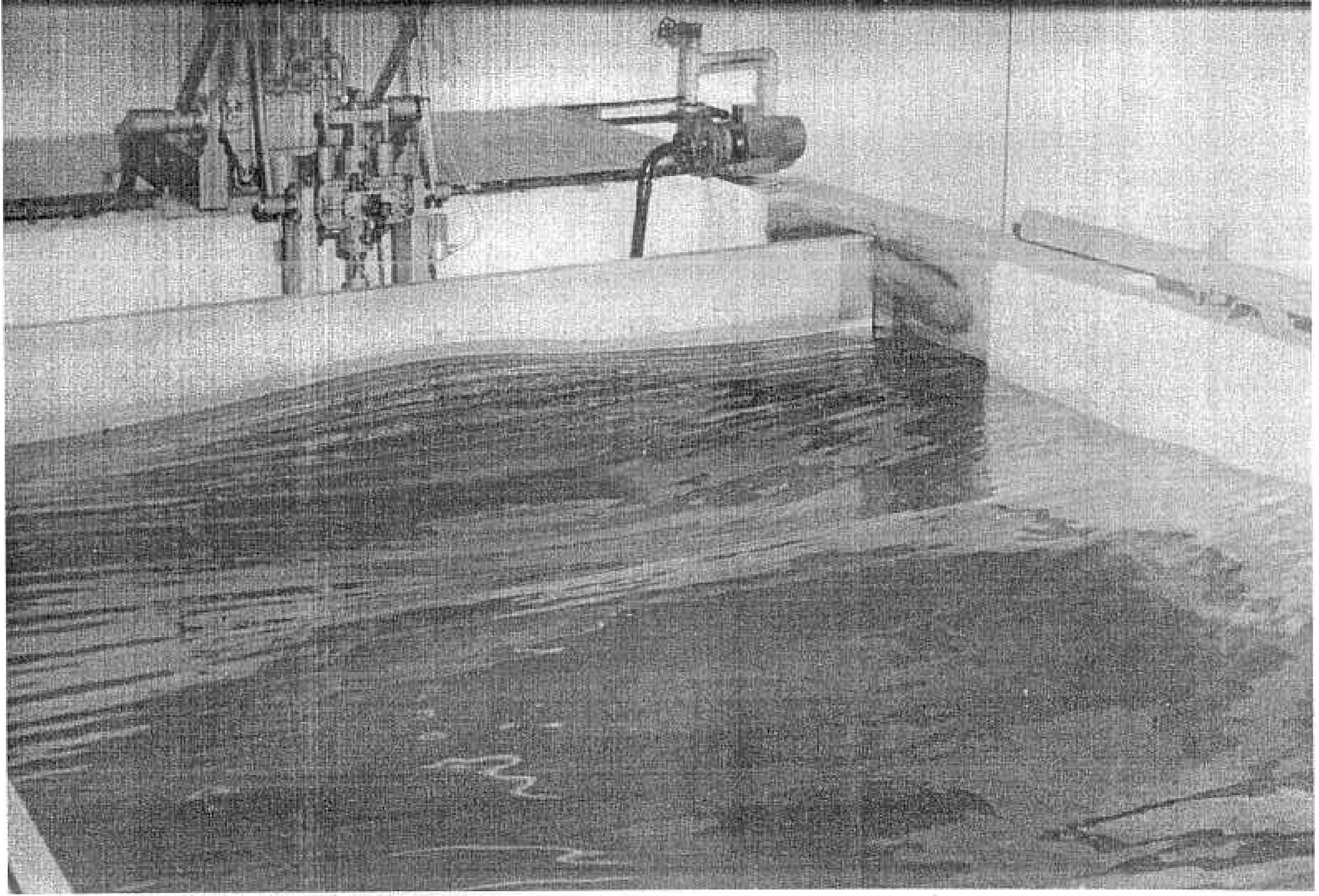
After preparing a detailed state-of-art report on the wave energy devices and systems, models of three wave energy devices were fabricated and tested. These are (1) oscillating water column system (2) single float system and (3) a double float system. Model tests were conducted in the 2m wide regular wave flume and in the 4 m wide random wave flume of the Ocean Engineering Centre, IIT, Madras. After the preliminary experiments, the wave energy group has decided that the oscillating water column (OWC) system is most likely to be the best device for application off the Indian coast. A bottom standing OWC system will also satisfy the multi-functional requirements as proposed.

In the meantime, a workshop on the 'utilisation and regulation of waves' was organised at the IIT, Madras from 14 to 17 March 1983 with the assistance of the British Council and the Department of Ocean Development. Three ocean energy experts from the United Kingdom viz. Prof. A. Long, Mr. S. Salter and Mr. G. Elliot and several representatives from the various organisations in India participated. The discussions in the workshop led to the same conclusion that the bottom standing OWC system is likely to be the most suitable for the Indian coast. It is still to be decided whether to use the Wells turbine or a Francis type of turbine for the power take off mechanism. A narrow flume with a random wave generator for testing small models in 2 dimensions is being designed.

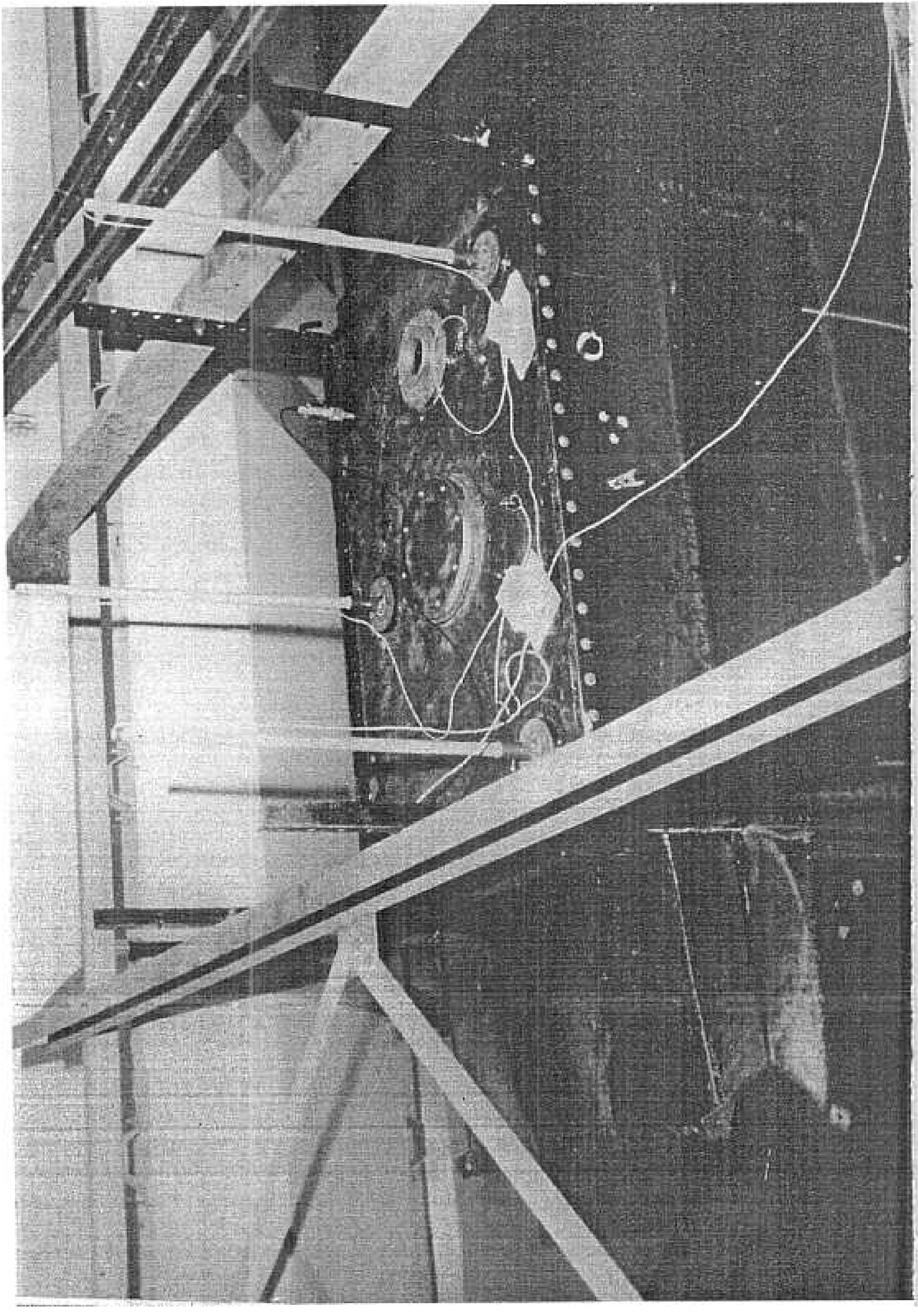
(a) Progress in the development of oscillating water column system.

A 2m wide terminator type oscillating water column (OWC), made of wood was installed in the 2m wave flume of the Ocean Engineering Centre, IIT, Madras. The experiment on this model gave preliminary ideas on the amount of air available for driving the turbine and the pressure rise in the OWC chamber. The air flow measured using the orifice plate installed in the vertical pipe.

Based on these preliminary results on the wooden model, a steel oscillating water column system has been fabricated. The model is one metre wide and 1.5 m in length in the normal



Twin Flap Random Wave Generator at the Ocean Engineering Centre, IIT, Madras.



and when placed along the direction of the waves. This model is being currently tested in the 4m random wave flume. The twin flap random wave generator is shown in the picture. The 4 m flume is 45m long and 2.5m deep. The maximum wave height that could be generated is about 0.35m. This steel oscillating water column models suspended from the top steel angles in the 4m flume is also shown in the picture. The main objective of this experiment is to find the optimum length of the device for a given wave length and to find out the optimum output from the OWC for a given wave climate. Pressure transducers and wave gauges are installed inside the OWC to measure the pressure rise and wave height inside the system.

The differentiated output of the wave height multiplied with the pressure transducers output gives directly the energy output of the device. The necessary wave gauges and the amplifier circuit have been fabricated in the Ocean Engineering Centre. One demonstration model of the self rectifying air turbine for the OWC system has also been fabricated. It has a model of 100 mm diameter air turbine with its rotar. The complete model was fabricated in the IIT, Madras. Bigger turbines for the experiments are also under fabrication. Computer work is also under progress for optimising the shape of the OWC.

6. ARRIVAL OF SAGAR KANYA IN INDIA

Sagar Kanya is one of the most modern oceanographic research vessels in the world today. It has full capabilities to work in the field of marine biology, marine geology, chemical and physical oceanography and meteorology. It has thirteen laboratories spread out on four decks. The ship is about 100 metres long and more than 16 metres in breadth with a gross tonnage of more than 4 thousand. It can attain a maximum speed of about 14 knots and is equipped with stabilisers which make it a very confortable ship to work on during the worst of monsoon weather. Equipped, as the ship is with bow thrusters and thin rudders, it has an excellent manoeuvrability.

Sagar Kanya
Germany. It was completed in
Development
exploration work carried out earlier
of the Indian
exploring geological
phosphate rocks
completed

Sagar Kanya
technicians

The oceanographic research vessel "SAGAR KANYA" of the Department of Ocean Development which arrived in India in June 1983.

ne sports room, a conference room, hospital and a medical attendant's room. The entire hip is air-conditioned.

Seven senior occupants have separate apartments, consisting of a day room, a bed room nd a bathroom each, and some are provided with refrigerators. Officers and engineers have ombined day/bed rooms : petty officers and senior ratings have also combined day/ edrooms. Some of the rooms contain two bunks in double tier.

Two fresh water generators have been installed in the ship to produce 40 cubic metres of resh water in 24 hours. Drinking water goes through filters and the ship produces enough vater to drink and for its use in the generators and laundry. Its waste water purification plant s laid out for 100 persons and utilises biological process for purification.

The operations centre of the ship is the bridge. All instruments needed for navigation and nanoeuvre are located there. These include a visual radio direction receiver, two echo-sounders, an electromagnetic speed log, a gyro compass, and electronic automatic pilot etc. t also has satellite navigation systems with a navigation computer interphased for research lata. A radio station, complete with marine radio telex and teleprinter equipment, is also vailable. There is a combined intercom-talk back system with 30 extensions and an utomatic telephone system with 50 extensions.

Various equipment and systems are available to scientists on board to sample the strata of the sea bottom, of surface rocks, sediments, plankton, fishes etc. It carries devices to take various oceanographic measurements and also to make motion pictures. It has various lifting devices and winches to lower and hoist various instruments as far out from the ship as possible so that they are not hindered by the ship's motion, currents and propellors. Gallows, cranes and jib boom are designed to operate clear from the ship sides. The hydraulic gallows have a lifting capacity of 22.5 tonnes. The central crane has a hoisting power of 6 to 8 tonnes. The jib boom is designed in such a way that things can be lowered into or lifted out of water without any difficulty. At an outreach of 3 metres, the jib boom has a capacity to handle 22.5 tonnes. A deep sea cable, 10,000 metre long and of 18 mm diameter runs over the jib boom. There are various kinds of winches to suit various types of observations

Each year the Indian sub-continent faces the monsoon and sometimes tropical cyclones. The monsoon is of utmost importance to Indian agriculture and economy and the monsoon phenomenon must be studied extensively by the Indian scientists. For this purpose a meteorological laboratory has been provided on "A" deck of *Sagar Kanya.* It records all values taken by the sensors installed in the ship itself, or by the buoys and balloons launched from the ship. Data thus collected are printed out by the computers on board. In addition to this, there is an APT Receiving Unit to receive fascimiles transmitted by the weather satellites Signals transmitted by an anchored buoy, 50 km away, can be received on board the ship.

The second meteorological laboratory is on "B" deck. It has the wind-weather radar controls. The costliest scientific appliances on the ship, the radome is controlled from here. A globe of fibre glass reinforced with plastic, of 5.8 metre diameter protects an 18 feet radar-mirror in the radome. It can both transmit and receive signals. It allows the projection of all kinds of precipitation and measures cloud and precipitation densities. The radar is fitted in such a way that its direction is never affected by the ship's motion. The radome also helps in tracing the weather balloons sent from the ship and records the data transmitted from them.

The ship is provided with a most modern computer room, a chart and a drawing room. The photo-lab, the print room, the multipurposes lab and electronics lab are the other special facilities with which the ship has been equipped.

Sagar Kanya can collect all types of data related to seismic, mannometry and gravimetry. Its 24 channel digital seismic equipment can provide information about the deep-seated sedimentary layers of the sea bottom. A chemical laboratory is provided with a salinometer, a thermosalinograph an auto-analyser and other equipment.

With all the above facilities and sophisticated equipment and systems on board, *Sagar Kanya* adds immensely to the oceanographical research capabilities of the country. The data collected will be of immense benefit in mapping the living and non-living resources in India's Exclusive Economic Zone and in the deep sea.

7. CRUISES OF SAGAR KANYA

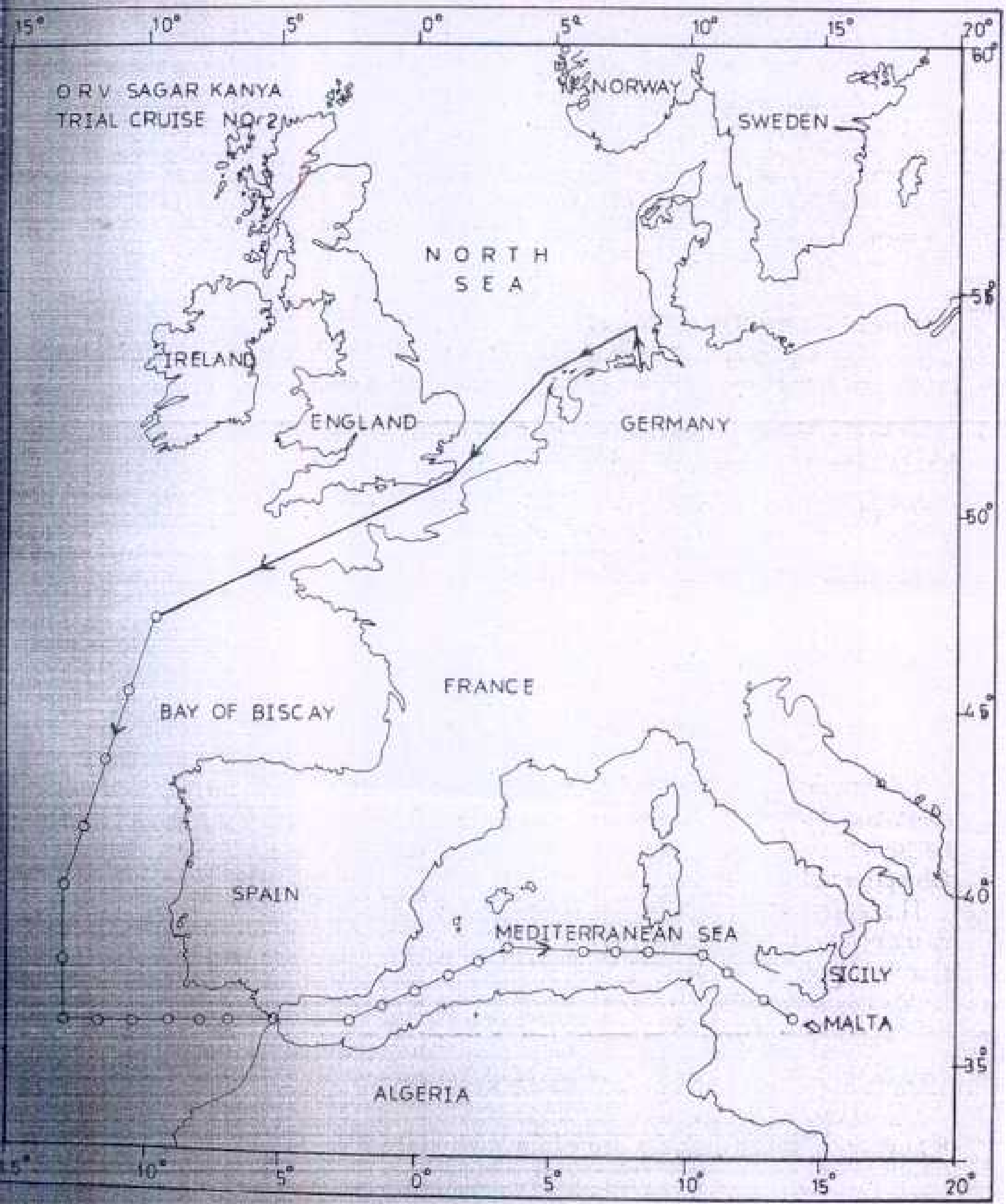
(a) Cruise 1

Leader of the cruise : Dr. V.V.R. Varadachari
Area of operation : Baltic Sea.
Port of Embarkation : Lubeck (Travemunde)
Port of Disembarkation : Lubeck (Travemunde)

This cruise was multi-disciplinary in nature and was undertaken to try out all types of oceanographic instruments on board. The cruise was initially intended for the German shipyard and the supplier and manufacturers of the various equipment installed in the ship to test and commission the various instruments. The operation of all the instruments was done in the presence of Indian scientists on board. The total duration of the cruise was 4 days. The ship left on 28 March 1983 and returned to Lubeck (Travemunde) on 1 April 1983. The performance of all the instruments, equipment and systems was very carefully watched and as and when any short-comings were noticed, these were fully rectified.

(b) Cruise 2

Leader of the Cruise :	Dr. T.S.S. Rao.
Port of Embarkation :	Lubeck (Travemunde)
Port of Disembarkation :	Malta



The track of 'Sagar Kanya' during the trial cruise 2. Open circles show stations worked.

Objective of the cruise :

This cruise was undertaken to test once again and try out the various instruments both in shallow and deep waters and to collect oceanographic information from the Bay of Biscay and also from the eastern Atlantic. Studies on the circulation and water exchange from the Mediterranean through the Strait of Gibraltar were also carried out. Oceanographic observations in the Western Mediterranean also formed a part of the cruise programme.

During the cruise, there were 12 participants from the National Institute of Oceanography, 8 from other Indian agencies and 12 German scientists. The total duration of the cruise was 17 days. The ship left Travemunde on 12 April 1983 and reached Malta on 29 April 1983.

Details of the work carried out :

Bathythermographs, hydrographic casts, plankton nets, various types of sampling bottles, corers and grabs were operated at every station during the cruise.

CTD system was operated at all the deep stations, magnetometer, seismic instruments and thermo-salinographs were operated while the ship was on the run between the stations.

All instruments on board were thoroughly tested. These included multi-channel auto analyser, AAS, navigational equipment, computer etc.

The track of the cruise 2 is shown in the report.

(c) Cruise 3

Leader of the cruise :	Dr. T.S.S. Rao
Port of Embarkation :	Malta
Port of Disembarkation	Bombay/Goa.

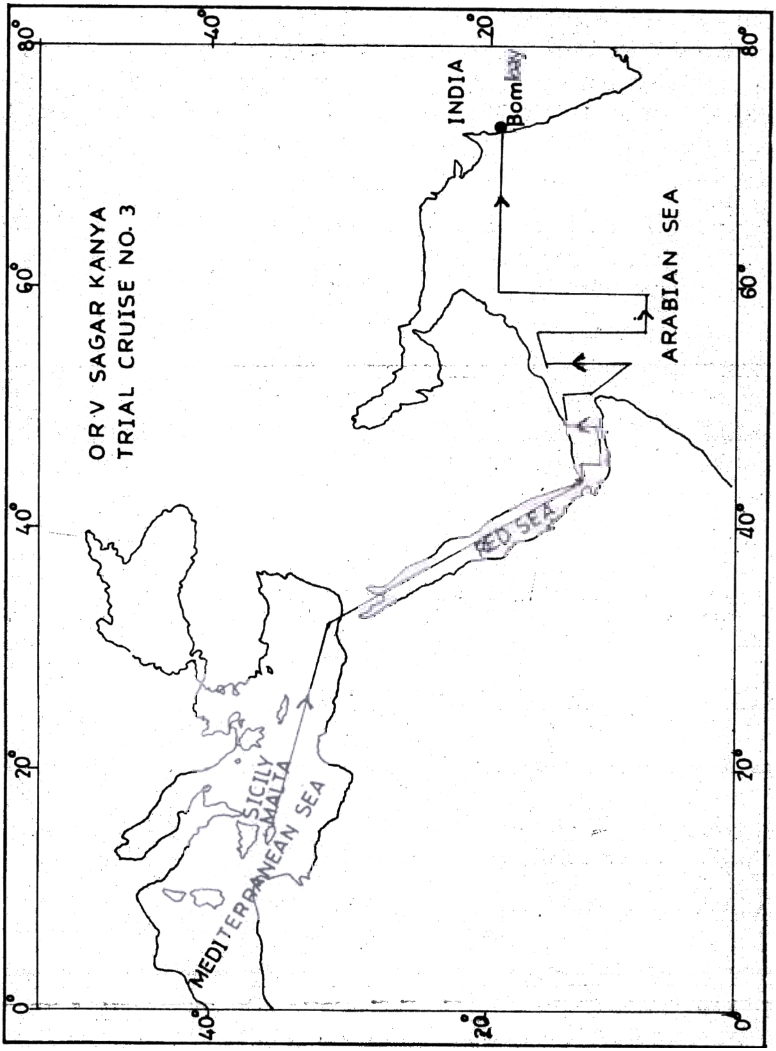
This cruise was multi-disciplinary and interagency in nature involving physical, meteorological, chemical, biological and geological oceanography with all type of marine instrumentation.

Objectives of the cruise :

The cruise was arranged to conduct an extensive and most rigorous test of the instruments and systems. Also it was the first scientific cruise planned for detailed studies. Oceanography of the eastern Mediterranean Sea, the Red Sea and from a part of the northwestern Arabian Sea was also undertaken. Circulation and water exchange through the Suez Canal and the Strait of Bab-el-Mandab were also studied.

Details of the work carried out during the cruise :

During the cruise, there were 12 participants from the National Institute of Oceanography, 8 from other Indian agencies and 12 German scientists.



The track 'Sagar Kanya during trial cruise

The ship left Malta on 13 May 1983 and reached Bombay on 24 June 1983, and Goa on 27 June 1983.

Bathythermographs, hydrographic casts, plankton nets, different types of sampling bottles, corer and grabs were used at every station during the cruise. CTD system was operated at all the deep stations. Magnetometer, seismic instruments and thermo-salinograph were operated while the ship was on the run between the stations. Current measurements at an anchor station in the Strait of Bab-el-Mandab were made and the instruments on board were also tested. These included the multi-channel auto analyser, AAS, navigational equipment, the meteorological equipment and all the four computers.

Red Sea :

ORV Sagar Kanya did a detailed study of the circulation in the Red Sea by collecting hydrochemical data along the central axis at 40 miles interval through its entire length. The results have revealed that nutrients are low in the Red Sea in comparision with the Arabian Sea.

In the Ethiopian Section of the Red Sea, a moored meteorological buoy was installed for 3 days to study the energy flow between the sea surface and atmosphere. The data collected indicated clearly that the ship borne measurements of meteorological parameters show higher values than those collected from the buoy.

Arabian Sea (North-Western area) :

By far the most interesting and important results have come from the meteorological studies in this area. The results have clearly shown that the onset of the Indian S.W. monsoon is preceded by the development of easterly winds in the atmosphere from the sea-level upwards.

The geophysical survey carried out both at the Owen Fracture Zone and the Carlsberg ridge around the area 2° to 30°N and 63° to 64° E revealed the well established classical pattern in the distribution of magnetic anomalies characteristic of the rift valley systems. This is perhaps the first time such an excellent result was obtained from the Carlsberg ridge by an Indian research ship. Manganese nodule was also obtained at a position 50° 42′ or and 65°00′E and this is perhaps the nearest nodule site from the Indian coast.

During the cruise 122 XBT's were taken as part of the IGOSS programme.

Summary of work of the maiden cruise of ORV Sagar Kanya from West Germany to India

Number of days of the cruise from Germany to Bombay	:	74
Total distance covered	:	10846 nm or (20088km)
Number of stations occupied	:	220

Number of scientific operations/experiments	443
Number of Indian scientists/technicians	16
Number of German scientists/technicians	16

The track of the trial cruise 3 is shown in the report.

(d) Cruise 4

Leader of the Cruise:	Shri L.V.G. Rao
Port of Embarkation:	Marmagoa.
Port of Disembarkation:	Marmagoa
Port of Call:	Mombassa (Kenya)

This cruise was multidisciplinary in nature involving physical, chemical and biological oceanography and marine instrumentation.

Objectives of the Cruise:

to carry out monsoon experiments,
to study upwelling and also
to study environmental parameters

During the cruise, 24 scientists and 8 technicians participated.

The total duration of the cruise was 53 days. The cruise left on 12 July 1983 and arrived back to Marmagoa on 2 Sept., 1983.

Description of the work carried out during the cruise:

During the cruise, studies were carried out in the western Arabian Sea particularly in the upwelling areas off the Somali Coast by conductivity, temperature, currents, nutrients and productivity.

Two scientists from the Kenya Marine and Fisheries Research Institute participated in the second part of the cruise. They were trained in the collection of oceanographic data.

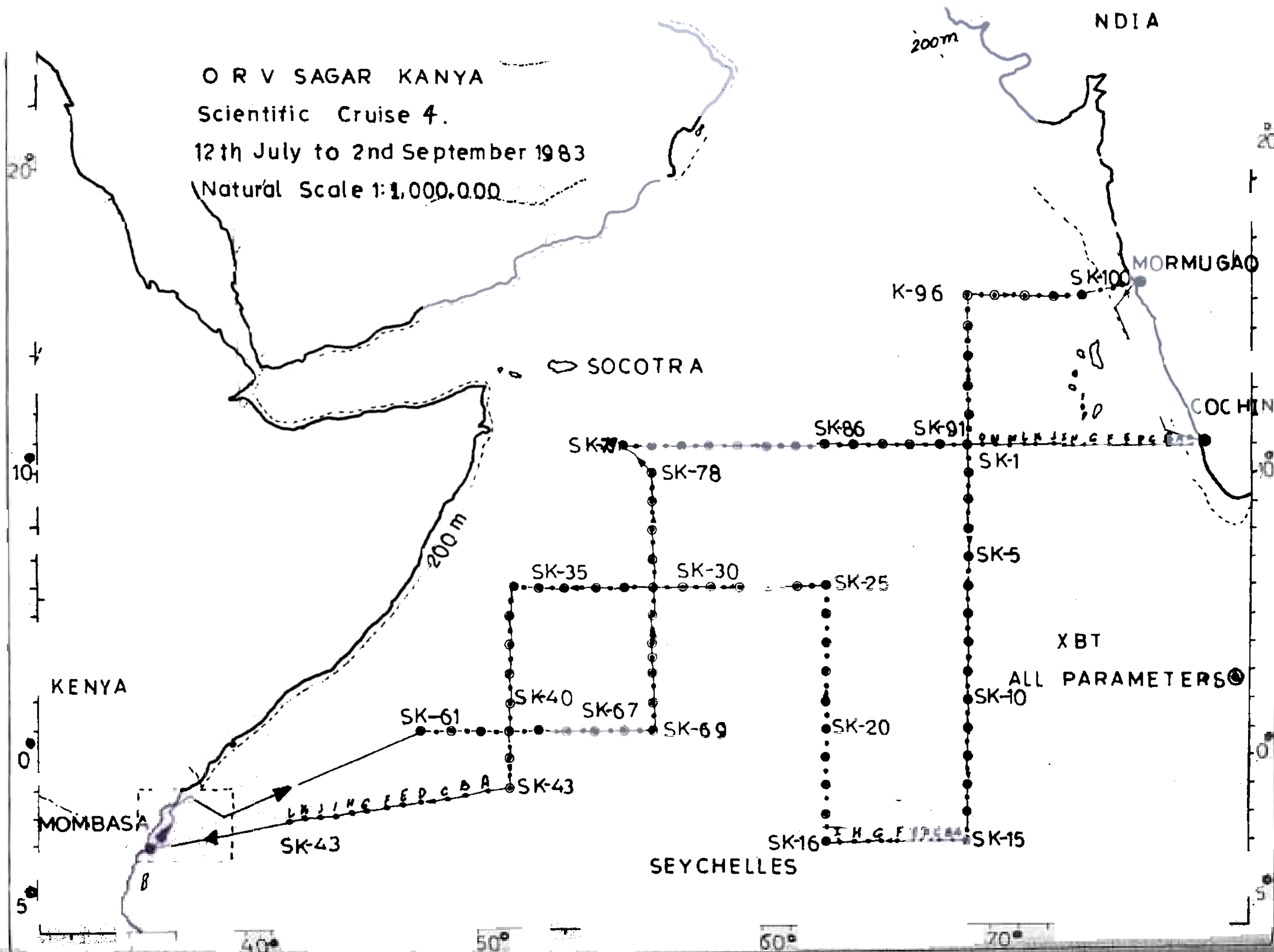
Some of the salient features observed during this cruise were:

Sea surface temperature of less than 26°C was recorded in the sea off the coast of Kenya.

East African coastal currents have speed upto 80 cm/sec off Lamu (northern part of the Kenya coast), and low level jet with speeds upto 50 knots at about 1.5 km height was recorded in the atmosphere. The track of this cruise and the stations worked have been shown in the report.

(e) Cruises 5 and 6:

At the time when this annual report was sent to the press, two more cruises of *Sagar Kanya* have been completed. The details of these cruises are awaited.


O R V SAGAR KANYA
Scientific Cruise 4.
12th July to 2nd September 1983
Natural Scale 1:1,000,000
NDIA
200m
MORMUGAO
COCHIN
SOCOTRA
KENYA
MOMBASA
SEYCHELLES
200 m
K-96
SK-100
SK-91
SK-86
SK-1
SK-5
SK-10
SK-15
SK-16
SK-20
SK-25
SK-30
SK-35
SK-40
SK-43
SK-61
SK-67
SK-69
SK-78
XBT
ALL PARAMETERS
20°
10
0
5
40°
50°
60°
70°

8. PROGRESS ON THE NEW FISHERIES AND OCEANOGRAPHIC RESEARCH VESSEL (FORV) FROM DENMARK

Another sophisticated Fisheries and Oceanographic Research Vessel (FORV), is being acquired from Denmark at a cost of about Rs 15.29 crores. This ship is being financed by a soft loan under Danish assistance and the ship is likely to be delivered by the end of 1984.

Important dimensions of the vessel are as follows:

(a) Length overall	: 71.50 metres
(b) Breadth moulded	: 16.40 metres
(c) Depth to fiecastle deck	: 11.70 metres
(d) Depth to main deck	: 9.00 metres
(e) Depth to free board deck	: 6.40 metres
(f) Weight	: 800 tonnes.

The vessel will be capable of carrying out marine fishery research including biological, physical, geological and chemical oceanographic observations as its major disciplines. It will be stabilised and will be capable of all weather operations including the monsoons for unrestricted international voyages. Its normal operation will be the different parts of the Indian Ocean region down to 60 degree south. The ship has been ice strengthened and therefore, it can operate in Antarctic waters.

CHARTERING OF SHIPS

The Department had chartered several ships from abroad to continue with its programme of ocean development. The vessel chartered during the year were:

(i) M.V. Skandi Surveyor:

This ship was used for the survey of the polymetallic nodules in the central Indian Ocean. It was chartered from P/R Oekland and Co., Torangsvaag, Norway.

(ii) M.V. Farnella:

This ship has been chartered from M/s. J. Marr & Sons Ltd., England. This vessel has also been used for the survey of polymetallic nodules.

(iii) Finnpolaris:

This ship has been chartered from O.Y. Finnlines Ltd, Finland for undertaking the third Indian expedition.

10. MANPOWER PLANNING

With the arrival of research vessel *Sagar Kanya*, the demand on the existing manpower ill increase considerably. Moreover, another vessel, (FORV) being built in Denmark is ɛely to join the above fleet by the end of 1984.

Exploration of the Exclusive Economic Zone (EEZ) and the deep sea areas including e rich Antarctic seas are of much interest to India to meet the growing demands for food d minerals during the next two decades. Remote sensing of ocean parameters is another ry promising area for development. Apart from the above activities, equal emphasis has be laid for the development of the centres of excellence in basic oceanographic research. ıerefore, it is very necessary to strengthen the much-needed research facilities in all the ɛas of ocean science and technology. Research and development activities in the field of ɛan sciences would require at least 1000 additional competent scientists and engineers the next 5-7 years. This additional scientific manpower will have to be supported by ɛquate infra-structure and administrative facilities. This would mean that we must have npower planning for at least 100 to 150 scientists per year. It is, therefore, necessary to e a serious thought to the development and training of manpower in the highly diversified ds of ocean science and technology in the country.

The Department of Ocean Development has undertaken a programme of manpower nning to meet the growing requirement of its programmes of ocean development. Each ject requires trained persons in different disciplines of oceanography to meet the growing ds in each marine sector. Therefore, a large number of scientists, technologists and ineers will have to be trained in the country.

here are several institutions and universities in the country which can take up training ;rammes. Several universities and IITs have started programmes in ocean science. to meet the required number during the next few years, the training in ocean science have to be increased in all the institutions which have interest in marine science.

he Department has provided extra positions of scientists, technicians to several tutions during the year.

wo methods are being tried for developing and increasing the trained manpower. In ɛmenting both these methods, the basic opportunities in the universities and in technical ation centres are also being strengthened.

n-house training :

iis is being undertaken in scientific institutions.

ganisations like CSIR, ICAR, Ministry of Agriculture, BARC, GSI, Indian Navy and hant Navy will be used for the in-house training to suit specific requirements. No r where the R & D programmes are undertaken in ocean science and technology, the ation of ship-board facilities and orientation course in ocean science should be deemed most basic and these should be implemented in the already existing training centres , CIFE, IIT, etc.)

(ii) Fellowships and research associateships programme:

The second method has been the award of a number of fellowships and research associateships to about 125 persons per year in different centres, universities, central organisations, which are involved in marine-oriented work. The fellowship scheme has certain distinct advantages as no major institutional set up is required for this purpose. The award of these fellowships can be done on a more broad-based scheme covering the entire country. The existing centres of excellence can be used to take new fellowships in specialised branches of marine science and technology. One of the goals of this method has been to develop a reservoir of young scientists with Ph.D., and Master's degree in different fields, from where the scientists could be drawn as the potential future marine scientists in specific mission-oriented work on research vessels in the Exclusive Economic Zone, deep sea and the Antarctic programmes. Another advantage of such a reservoir of scientists is that they have their roots in various institutions from where they will be drawn for specific work and they will continue to carry out their work in their parent institutions.

Both the two methods are being implemented by the Department and the response towards the fellowship and research associateship scheme by the various institutions has been extremely rich and enthusiastic and many fellow and research associates are already in position.

11 FORMATION OF OCEAN COMMISSION

During the year, the Department evaluated the various options available for implementing the various programmes of ocean development. The Indian Institute of Management, Ahmedabad was asked to give a detailed report on the structure of the Ocean Commission. The study was carried out in greater detail after consulting the various agencies and the Indian Institute of Management has submitted a detailed report to the Department. The Department is studying the report and is in touch with other organisations which are having a commission-like structure. The Department will be able to finalize a proposal for the approval of the Government of India, soon.

12. COLLABORATION AND ASSISTANCE PROVIDED TO OTHER COUNTRIES OF THE INDIAN OCEAN REGION

(i) Collaboration with Seychelles:

A programme of collaboration in ocean science between the Government of India and Government of Seychelles was initiated for the exploration for seabed resources and polymetallic nodules in the waters of Seychelles. The Government of Seychelles requested the Department of Ocean Development to prepare a general brief on the type of cooperation ɔuld be offered. The following areas of cooperation were identified by the ment.

ining of experts of the Government of Seychelles in conducting the survey of EEZ of ·Z of Seychelles as well as of polymetallic nodules.
ɔutation of suitable technical/technological personnel from India to Seychelles,
ıt surveys in the EEZ of Seychellas and of the high sea, and
:ing up of an appropriate research and survey organisation in Seychelles.

e were conveyed to the Government of Seychelles through our High Commissioner. nister for Planning and External Relations, Government of Seychelles requested for patch of an Indian mission for preliminary discussions and finalisation of ments for the collaboration. A four member delegation visited seychelles from 24 28 July 1983.

sentation was given by the Indian delegation indicating the expertise developed by the field of oceanography and the facilities it could offer to the Government of les. It was indicated by the Seychelles side that in Seychelles there was ·able shortage of trained manpower. As such, it would be difficult for them to avail ıining facilities in India. The Government of Seychelles was, however, keen that a e carried out to locate polymetallic nodules and other resources in their EEZ and ling waters.

isit of the Indian delegation was followed by a visit of a senior officer from es to Goa who visited the National Institute of Oceanography and held discussions scientists. In November, 1983 the Foreign Minister of Seychelles visited the Institute of Oceanography to finalise the arrangements of collaborations.

ɾovernment has decided that in March, 1984 *R.V. Gaveshani* should visit ɜs to carry out the proposed survey work.

.aboration with Mauritius:

request of the Government of Mauritius a seat was offered to Mauritius to e in the second expedition to Antarctica. This however, could not be availed by ıuse of the shortage of trained persons there. Mauritius has intimated that they will ɪe invitation by India at a later convenient time.

-Sri Lanka co-operation in ocean research:

ȷation from Sri Lanka visited the Department of Ocean Development and had iscussions with the Secretary and other senior officials of DOD and CSIR (NIO) the co-operation between India and Sri Lanka in the field of research and ɜnt in marine science.

ɜult of the discussions held, two scientists from Sri Lanka participated in cruise *V. Gaveshani* in the Bay of Bengal. These scientists were trained in taking observations on different aspects of oceanography. In physical oceanography, they are trained in carrying out measurements of currents, temperature, humidity, pressure, wind direction and wind speed. In biological oceanography, they worked on primary productivity, zooplankton collection and preservation and microbiological studies. In chemical oceanography, they carried out work on the analysis of nutrients such as nitrate, nitrite, ammonia, phosphate and dissolved oxygen.

One research officer from Sri Lanka participated in the International Training Programme on Marine Resources Management and Conservation in the Indian Ocean and Adjacent seas, held at the National Institute of Oceanography, Goa. The training programme was funded by the Department of Ocean Development, International Ocean Institute , Malta and several international agencies.

Two Indian scientists from India were sent to Sri Lanka under the ITEC programme to help in the development of marine science infrastructure and institutional facilities in Sri Lanka.

The Indian Research Vessel, *R. V. Gaveshani* paid a goodwill visit to Colombo during the year and this gave an opportunity to the scientists of Sri Lanka to visit the vessel and look at its capabilities for carrying out multidisciplinary work in oceanography.

A delegation from India attended a "Conference on the Development of Marine Resources, Science and Technology in Colombo".

13. MARINE RESEARCH AND DEVELOPMENT FUND

(a) Assistance to institutions:

During the year, the Department has provided assistance to a large number of organisations and universities in the country for holding symposia, seminars and workshops on marine science and related subjects.

The universities and organisations which were given assistance during the year 1983-84 include:

1. Central Water and Power Research Station, Pune.
2. Centre for Advanced Studies in Botany, University of Madras.
3. Association of Exploration of Geophysics, Osmania University, Hyderabad.
4. Department of Bio-sciences, Saurashtra University, Rajkot.
5. Indian Institute of Technology, Madras.
6. Central Scientific Instruments Organisation, (CSIR), Chandigarh.
7. Centre for Water Resources Development & Management, Kozhikode.
8. International Congress of Genetics, New Delhi.
9. Indian Fisheries Association , Bombay.

[ndian Historical Congress, New Delhi.
Vational Institute of Oceanography, Goa.
Coastex Saahil Yatra, New Delhi.

e subject on which assistance was provided included ocean engineering, instrument-, geophysical problems related to ocean sciences, biometeorology, ecology, metereo- marine algae, etc.

Exhibition on ocean and its resources :

e Department of Ocean Development, in collaboration with the Jawaharlal Nehru orial Fund, organised an exhibition on the theme "Ocean and its Resources" at Teen House, New Delhi from 14 to 20 November, 1983. The inauguration of the exhibition ded, New Delhi with the birth anniversary of Pandit Jawaharlal Nehru. The organis which took part in the exhibition were the National Institute of Oceanography, Goa; ntral Salt & Marine Chemicals Research Institute, Bhavnagar; the Physical Research atory, Ahmedabad; the Central Institute of Fisheries Education, Bombay; the ial Council of Educational Research and Training, New Delhi; the Oil & Natural Gas iission and the Indian Navy.

ddition to the above organisations, the National Book Trust of India displayed a y of books. Shri R.P. Sharma from Jaipur, a private collector of photos of the Nehru also participated and displayed photos on the life of the late Prime Minister arlal Nehru and pictures and other information he had collected since his childhood. ati Indira Gandhi, Prime Minister of India was present at the inaugural function of the tion. The exhibition was inaugurated by Shri Shivraj V. Patil, Minister of State for Development. The Prime Minister in the company of several Ministers an distind scientists went round the exhibition.

main purpose of this exhibition was to create an awareness about the sea and its ces in the capital so that interest among the people of India and specially among the -going children and college students is generated and they become motivated to take rine science or work on the technological innovations in the ocean sector. The ion had many working models, exhibits, charts, maps and instruments connected dia's efforts on the exploration and exploitation of living and non-living resources of

ng resources had the following themes :

pture fisheries
ariculture
le of estuarine and brackish water culture in rural economy
aweed resources of India
tential of food from the sea.

The Prime Minister visiting the exhibition on "Ocean and its Resources" organised jointly by the Jawaharlal Nehru Memorial Fund and the Department of Ocean Development.

ng Resources had the following well-defined themes :

and climate
from the sea
: chemicals
'ater from saline water
ces from the sea bed

from the continental shelf and from the deep sea such as polymetallic nodules /ed using various types of charts and exhibits. A working model on the collection illic nodules from the deep ocean bed was a big attraction to the visitors.

ıe theme living resources, there were functional models and exhibits on , mariculture, brackish water culture and on how it could be used as an industry for employment and extra food resources. Seaweeds also formed an important their utilisation as food and for various industrial purposes.

evant photographs depicting the two successful expeditions to Antarctica, core lected from the Antarctic land mass, rocks of Antarctica and the model of the :rmanent Indian station to be set up at Dakshin Gangotri by the third expedition yed. Film and video shows on the Antarctic expeditions and on other ocean ıt activities were also arranged during the exhibition.

:er marine archaeology collections made by NIO, Goa from the continental shelf generated a lot of interest among the daily visitors.

ır on oceans and climate :

ır on oceans and climate was organised at National Institute of oceanography 28-29 October, 1983, as part of the 53rd Annual Session of the National f Sciences, India.

nar was inaugurated by Dr. P. Koteswaram, former Director-General of the ›rological Department on 28 October. Dr. S.Z. Qasim, secretary, Department 'evelopment, presided over the function. Dr. V.V.R. Varadachari, Director, stitute of Oceanography, welcomed the gathering.

:waram in his inaugural address, urged the scientists to make dedicated efforts ıd the origin and development of the monsoons and their vagaries to facilitiate :ecasts. He stressed the importance of observations over the oceans for he progress of monsoon on a day-to-day basis and for estimating the amount of noisture that the monsoon winds pick-up from the oceans. He pleaded that sibilities of satellite observations should be fully utilized by the meteorologists raphers to improve weather prediction. He suggested that IMD should work in ı with DOD and that a "National Committee for Oceanic and Atmospheric hould be established soon to co-ordinate and encourage research activities in

Dr. Qasim, in his presidential address, emphasised the influence of oceans on weather. He touched upon the history of NIO and IMD and lauded the pioneering work done by these organisations in oceanic and climatic studies. He mentioned about the recent Indian expeditions to Antarctica and explained their importance in the context of the influence of Antarctica on the weather and climate over India.

The inaugural session was followed by three technical sessions during which 8 papers were presented by the invited experts from different organisations. The papers covered various topics such as oceanic influence on monsoon and rainfall variability, climate and satellite observations, modelling and weather prediction, etc.

As a continuation of the seminar, a poster session was conducted in the forenoon on 29 October 1983. Eleven papers on various topics, contributed by scientists from different organisations were displayed and discussed at the poster session. The participating scientists were from NIO, NPOL, IMD, IISc., SAC (ISRO) and PRL.

14. BUDGET

PLAN

The budget estimate (BE) of the Department of Ocean Development for the year 1983-84 was Rs. 3200 lakhs, while the figures for revised estimate (RE) for 1983-84 are Rs. 2340 lakhs. A budget estimate of Rs. 2244 lakhs has been made for the year 1984-85. A summary of the financial requirement is given below :-

PLAN (Rs. in lakhs)

Sl. No.	Item	BE 1983-84	RE* 1983-84	BE 1984-85
	CONTINUING SCHEMES			
1.	Research expedition to southern Indian Ocean and Antarctica	700	585	657
2.	Oceanographic research vessel (ORV)	1100	1080	300
3.	Fishery and oceanographic research vessel (FORV)	50	20	340
4.	Other research vessels	300	—	100
5.	Polymetallic nodules programme	960	600	650
6.	Studies on prevention of coastal erosion and wave energy	25	15	25
7.	Marine research and development fund	30	25	60
8.	Manpower training for ocean research and management	20	5	30
9.	Other schemes	3	1	5
10.	Other expenditure	12	9	22
	NEW SCHEMES :			
1.	Remote sensing for oceanographic data collection	—	—	30
2.	National oceanographic information system	—	—	5
3.	Exhibitions, fairs etc.	—	—	20
		3200	2340	2244

NON-PLAN

The non-plan component is required only for the secretariat expenses of the Department. A provision of Rs. 26.75 lakhs was made during 1983-84 for this purpose. A provision of Rs. 27 lakhs for the year 1984-85 has been made for the secretariat expenses.